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The Antarctic genus *Callozostron* and its relationship to *Primnoella* (Octocorallia: Gorgonacea: Primnoidae)

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Abstract.—Specimens of the gorgonacean genus *Callozostron* obtained in Antarctic waters during operations conducted by the U.S. Antarctic Research Program reveal that *Callozostron horridum* Kükenthal, 1909, is a junior synonym of *Callozostron mirabile* Wright, 1885. *Callozostron carlottae* Kükenthal, 1909, is confirmed as a valid species, and two new species, *Callozostron diplodiadema* and *Callozostron acanthodes* are described. All species are illustrated by stereoscopic scanning electron micrographs (SEM). The genus *Primnoella* Gray, 1858, is restricted to the "Compressae" species group, and polyps and sclerites of *Primnoella australasiae* (Gray, 1850), type species of the genus, are illustrated by SEM for the first time. A new genus, *Convexella,* is established for the "Convexae" species group of *Primnoella,* and polyps of *Primnoella magelhaenica* Studer, 1879, type species of *Convexella,* from a wide bathymetric and geographic range are illustrated by SEM to show morphological variation within the species.

During biological operations of the U.S. Antarctic Research Program (USARP), several deep-water dredge and trawl tows in Antarctic waters have yielded specimens of the three species of *Callozostron* so far described, *C. mirabile* Wright, 1885, *C. carlottae* Kükenthal, 1909, and *C. horridum* Kükenthal, 1909. This material shows that *C. horridum* cannot be maintained as a species separate from *C. mirabile,* and that a species distinct from *C. carlottae* remains to be described, in addition to a new species having a branched colony unlike any known heretofore. These are here described respectively as *Callozostron diplodiadema* and *C. acanthodes,* new species.

Operations of USARP in the Patagonian region and on Burdwood Bank have obtained numerous colonies attributable to *Primnoella magelhaenica* Studer as reported by Thomson & Ritchie (1906, as *magellanica*) from the *Scotia* cruise and by Broch (1965) from the *Brategg* expedition. These show sufficient variation to accommodate both *Primnoella magelhaenica* and *P. flagellum* as described by Studer (1879) from the same geographical area. The largest colonies are superficially almost indistinguishable from specimens of *Callozostron diplodiadema* new species and *C. carlottae* Kükenthal, obscuring but not eliminating the distinction between *Primnoella* and *Callozostron.*

Preparation of samples.—In general, sclerites, intact whorls and isolated polyps were prepared according to methods described elsewhere (Bayer & Stefani 1989: 450–451). However, in order to determine the arrangement of opercular and circumopercular sclerites, single polyps were individually macerated in Sodium hypochlorite solution and observed under the dissecting microscope during the process in order to distinguish opercular from circumopercular scales, and the isolated sclerites washed one by one by tranferring them through a series of drops of distilled water, drying, and mounting in sequence on SEM stubs.

Callozostron P. Wright, 1885

Callozostron P. Wright, 1885:691.—Studer [& Wright], 1887:48.—Wright & Studer, 1889:48.—Versluys, 1906:124.—Kükenthal, 1912:331; 1915:152; 1919:449; 1924:306.—Bayer, 1981:936 (in key only).—Bayer & Stefani, 1989:455 (in key only). (Type species: *C. mirabile* Wright & Studer, 1889, by subsequent monotypy.)

Diagnosis.—Flagelliform, unbranched or sparsely branched primnoids with tall, cylindrical polyps standing almost vertically from the axis, arranged in whorls; bases of polyps may be partially fused to form unbranched polyp leaves; opercular scales of nearly uniform size, distinctly differentiated from marginal scales; at least 4 marginal scales with very long, slender apical spine; body completely covered by scales. No irregular, tuberculate sclerites in walls of longitudinal stem canals.

Remarks.—In my key to octocoral genera (Bayer 1981:936), *Callozostron* is not distinguished from *Ainigmaptilon,* in both of which the polyps partially fuse to form pennatulacean-like "polyp-leaves." However, the spiculation of the polyps differs in the two genera. All nominal species of *Callozostron* have 8 well-differentiated smaller opercular scales within a ring of large marginal scales bearing long apical spines. In *Ainigmaptilon* the distalmost 8 scales are larger than the marginals, which are not well differentiated from the body scales below. Those of *A. antarcticum* (Molander) are triangular, with a broadly pointed apex (Molander 1929: fig. 22a) reminiscent of the opercular scales of *Primnoella gracilis* Molander (1929: fig. 18a), and those of *A. virgularoides* (Molander) are lancet-shaped with a short apical spine. In *A. edisto* Bayer (1950: fig. 2a) they bear long, smooth spines, and in *A. haswelli* Dean they have a strong, serrated apical spine (Thomson & Rennet, 1931: pl. 13, fig. 1). The 8 distalmost polyp scales of *A. antarcticum* and *A. virgularoides* converge over the infolded tentacles in a manner similar to those of *Primnoella gracilis* Molander, but in *A. haswelli* and *A. edisto* these scales cannot fold over the tentacles because of their long apical spines. Molander (1929), Carlgren (1943) and Bayer (1950) call these sclerites "Deckschuppen" or "opercular scales" whether or not they have long spines but, in fact, there is no functional "operculum" as in *Callozostron.*

In the examples so far reported, the axis of *Ainigmaptilon* terminates basally in a funnel-shaped expansion which encloses a quantity of mud that served to anchor the colony in soft substrate, whereas in those cases that are known, the axis of *Callozostron* terminates in a small, discoidal holdfast for attachment to solid substrate.

Most records of *Ainigmaptilon* are from shallow or moderate depths: *wallini*: 75 m; *antarcticum,* 125 m; *haswelli*: 517–549 m; *edisto*: 182 m; USNM records of *antarcticum*: 88–526 m; *edisto*: 182–662 m.

Except for one doubtful record, specimens of *Callozostron* have been taken at much greater depths, usually below 1000 m and mostly between 2000 and 3000 m.

Accordingly, there seems to be no doubt that both *Callozostron* and *Ainigmaptilon* should be treated as valid genera separable on the basis of differences in the opercular and circumopercular scales as mentioned above.

In the discussion of his new genus *Lycurus* (= *Ainigmaptilon*), Molander (1929: 70) pointed out the similarities of the genus to *Primnoella gracilis* and suggested that it may have arisen from such a form. A strong morphological similarity also exists between *Callozostron* and certain *Primnoella* species including *P. magelhaenica* Studer and *P. flagellum* Studer.

In *Callozostron carlottae* Kükenthal and *C. diplodiadema* new species, the basal fusion of adjacent polyps is minimal (see Figs. 9, 11, and Kükenthal 1912:334, fig. 43), inviting comparison with *Primnoella magelhaenica* Studer, in which the polyps are not appressed to the axis and often (but

not always) stand out almost vertically (see Figs. 21, 23, 27, and Broch 1965: pl. 1, fig. 1). *Primnoella magelhaenica* has distinctly pointed marginal scales that surround and overlap the opercular scales proper. In this respect, the polyps of *P. magelhaenica* are similar to those of *C. carlottae,* differing most conspicuously in the absence of strongly developed apical spines on the scales of three whorls surrounding the operculum, which is poorly differentiated from, and partially covered by, the marginal (circumopercular) sclerites.

Key to species of *Callozostron*

1(2). Colonies dichotomously branched, polyps arranged in whorls. Whorls composed of up to 6 polyps. Apex of opercular scales prolonged as a narrow spine. Marginal spines smooth, about 7× as long as height of basal part ..... *acanthodes,* new species

2(1). Colonies flagelliform, sometimes bifurcate but not repeatedly branched, polyps arranged in whorls that may be densely crowded. Apex of opercular scales more or less acutely pointed but not prolonged as a narrow spine.

3(4). Whorls sometimes densely crowded and more or less obscured, composed of as many as 12 or even more polyps; polyps about 3 mm tall exclusive of marginal spines; marginal spines smooth, slender, 4–6, commonly 4, developed only on the marginal transverse row of body scales, 2–3× as long as the height of the wide basal part ..... *mirabile*

4(5). Colonies flagelliform or bifurcate. Whorls distinct, composed of 8–9 polyps; polyps about 2 mm tall exclusive of marginal spines; marginal spines stout, with raised longitudinal ridges, about 24, developed on 3 transverse rows of body scales, about 2× as long as height of basal part ..... *carlottae*

5(1). Colonies flagelliform. Whorls distinct, composed of up to 14 polyps; polyps about 2 mm tall exclusive of marginal spines; marginal spines slender, smooth, about 16, developed on 2 transverse rows of distal body scales, about 5× as long as height of basal part . . .*diplodiadema,* new species

Callozostron mirabile Wright, 1885
Figs. 1, left; 2–6

Callozostron mirabile Wright, 1885:691, figs. 234, 235.—Wright & Studer, 1889: 48, pl. 10, figs. 1–5; pl. 20, fig. 1.—Versluys, 1906:124.—Kükenthal, 1912:328–333 *passim*; 1919:450; 1924:306.—Schimbke, 1915:22.

Callozostron horridum Kükenthal, 1909:49; 1912:331, figs. 38–42, pl. 22, figs. 12, 13; 1919:451; 1924:307.—Schimbke, 1915: 23.

Material.—Antarctica, Oates Coast: 64°59′S, 160°36′E, 2836–2864 m, USNS *Eltanin* sta. 1957, 7 Feb 1967; one colony USNM 78662. South Atlantic Ocean, between South Orkney Islands and Palmer Peninsula: 63°03′S, 49°11′W, 2653–2941 m, USNS *Eltanin* sta. 529, 3 Mar 1963; 2+ colonies USNM 77377 (SEM 1159). South Atlantic Ocean, off South Georgia Island: 56°04′S, 33°59′W, 3239–3138 m, USNS *Eltanin* sta. 722, 8 Sep 1963, 5+ colonies USNM 77378 (SEM 1160, 1166, 1167, 1622, 1623). South Atlantic Ocean, off South Georgia Island: 54°00′S, 33°40′W, 2718–2663 m, USNS *Eltanin* sta. 723, 9 Sep 1963. 1 colony USNM 77381. South Atlantic Ocean, off South Sandwich Islands: 57°22′36″S, 26°34′00″W, 2248–2402 m, R/V *Islas Orcadas* sta. 51, 26 May 1975, 1+ colony USNM 82876 (SEM 1624, 1625). South Atlantic Ocean, off South Sandwich Islands: 57°39′24″S, 26°26′42″W, 415–612 m, R/V *Islas Orcadas* sta. 52, 26 May 1975, 1+ colonies USNM 77339 (probably a contaminant from sta. 51). South Pacific Ocean, off Antipodes Island, New Zealand: 49°40′S, 178°56′E, 952–1336 m, USNS *Eltanin* sta. 1852, 3 Jan 1967, 3+ colonies USNM 77402. Scotia Sea: 60°02′S, 49°14′W, 3819–3876 m, USNS *Eltanin* sta. 545, 7

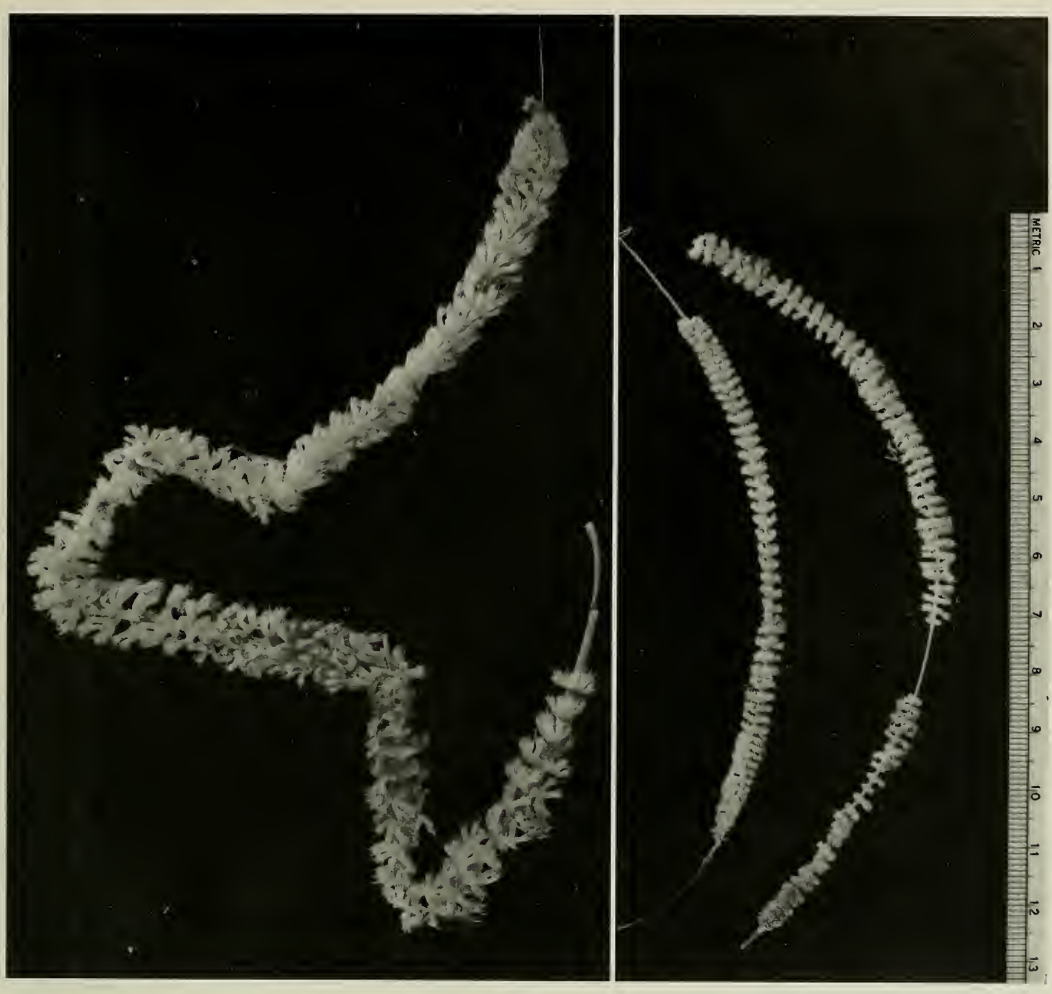


Fig. 1. Left, *Callozostron mirabile* Wright, USNM 82876. Colony with axis still in place but broken; Right, *Callozostron diplodiadema* new species, USNM 77386. Two incomplete colonies (syntypes).

Mar 1963, 1 incomplete colony ripped from axis and broken, USNM 85294 (SEM 1630–1634).

Diagnosis.—*Callozostron* with up to 12 or more polyps in whorls that may be obscured by close crowding. Long, slender apical spine developed on 4–6 marginal scales of polyps.

Remarks.—The distalmost whorl in a colony may consist of as few as 4 polyps (Fig. 3), but this number quickly increases proximad. Fully developed polyps (Fig. 2, top) are about 3 mm tall excluding the 4–6 long, marginal spines (Fig. 2, bottom), which usually are more or less broken, and indistinctly united by their bases into groups of a few individuals (Fig. 2, top). In contraction, eight distalmost polyp scales fold over the retracted tentacles as a conical operculum (Fig. 4). The marginal scales of immature polyps (Fig. 5) do not have the long apical spine present on fully developed individuals (Figs. 2, 4). Sclerites (Fig. 6) are of the generalized primnoid type: thin, rounded scales with finely dentate margins, smooth externally and covered with closely set complex tubercles internally, those of the polyp body (Fig. 6c) larger than those

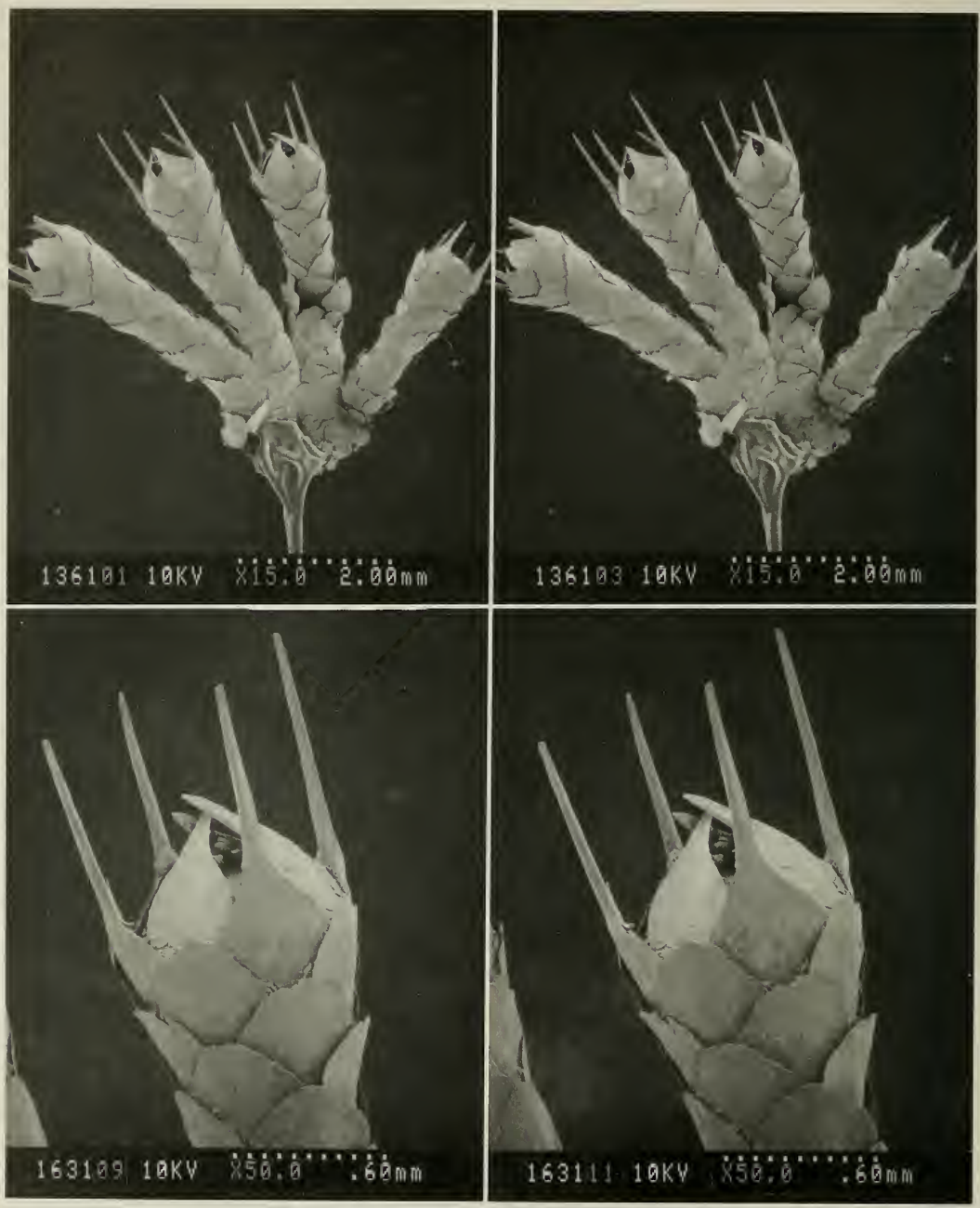


Fig. 2. *Callozostron mirabile* Wright, USNM 85294. Top, Four polyps from a whorl; Bottom, Detail of oral end of polyp with four marginal scales prolonged into spines. Stereoscopic pairs (SEM 1631).

of the coenenchyme (Fig. 6d); the opercular scales are of the usual roughly triangular shape, thin, with a broad, shallow apical groove. Four to six of the marginal scales are unusual in having an exceptionally long, thin, fragile, apical spine (Fig. 6b).

The present material provides evidence that the coenenchyme and polyps of the

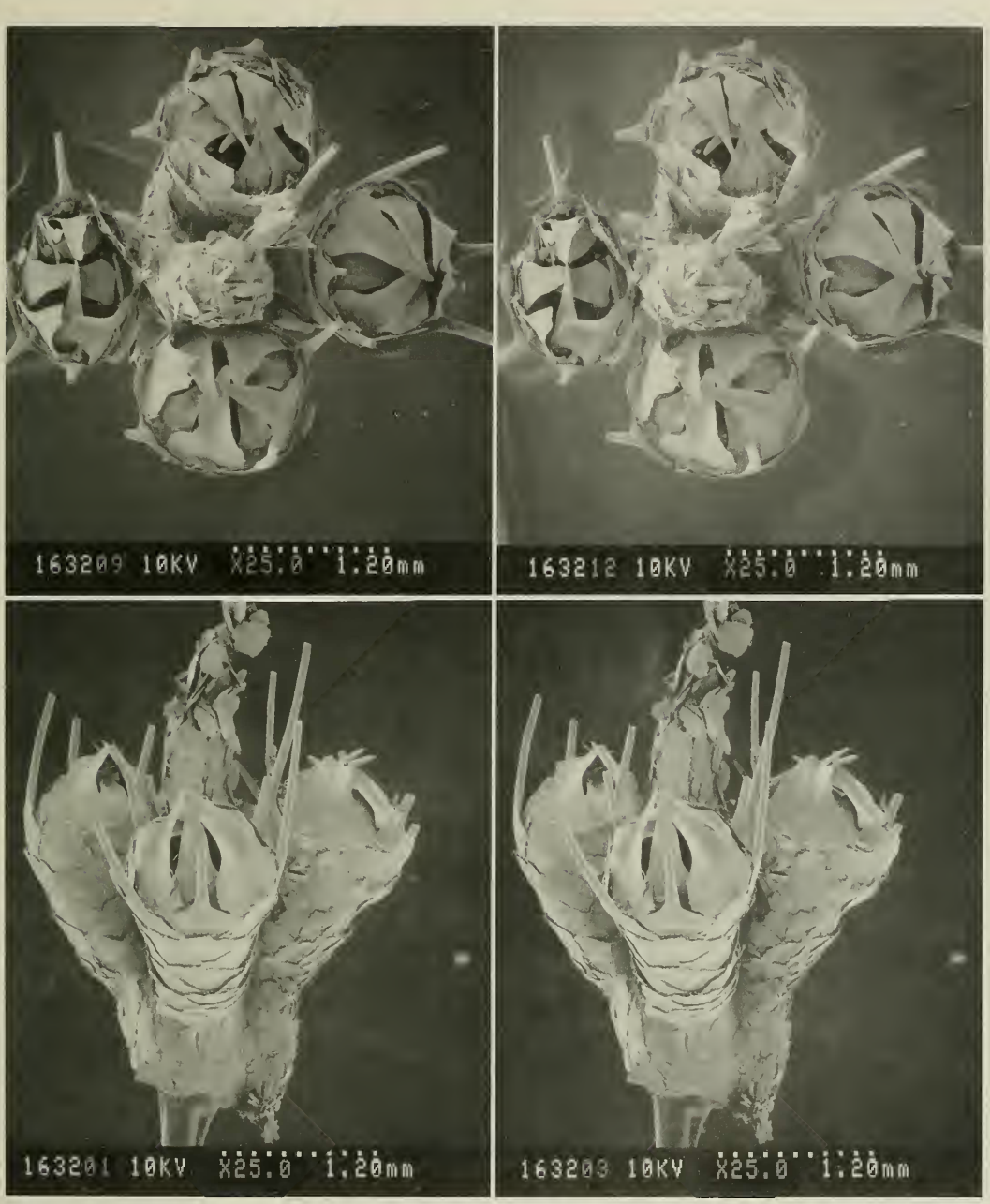


Fig. 3. *Callozostron mirabile* Wright, USNM 85294; whorl with only four polyps, from distal end of colony. Top, Oral view; Bottom, Side view. Stereoscopic pairs (SEM 1632).

original type specimen may have been stripped from the axis during collection and the whorls tightly compressed together as shown in the original figures. Some of the specimens here reported are similarly damaged. Some have a well-developed axis (Fig. 1), and some have been stripped off of the axial skeleton during collection. Furthermore, as specimens of *Callozostron carlottae* Kükenthal, *Primnoella magel-*

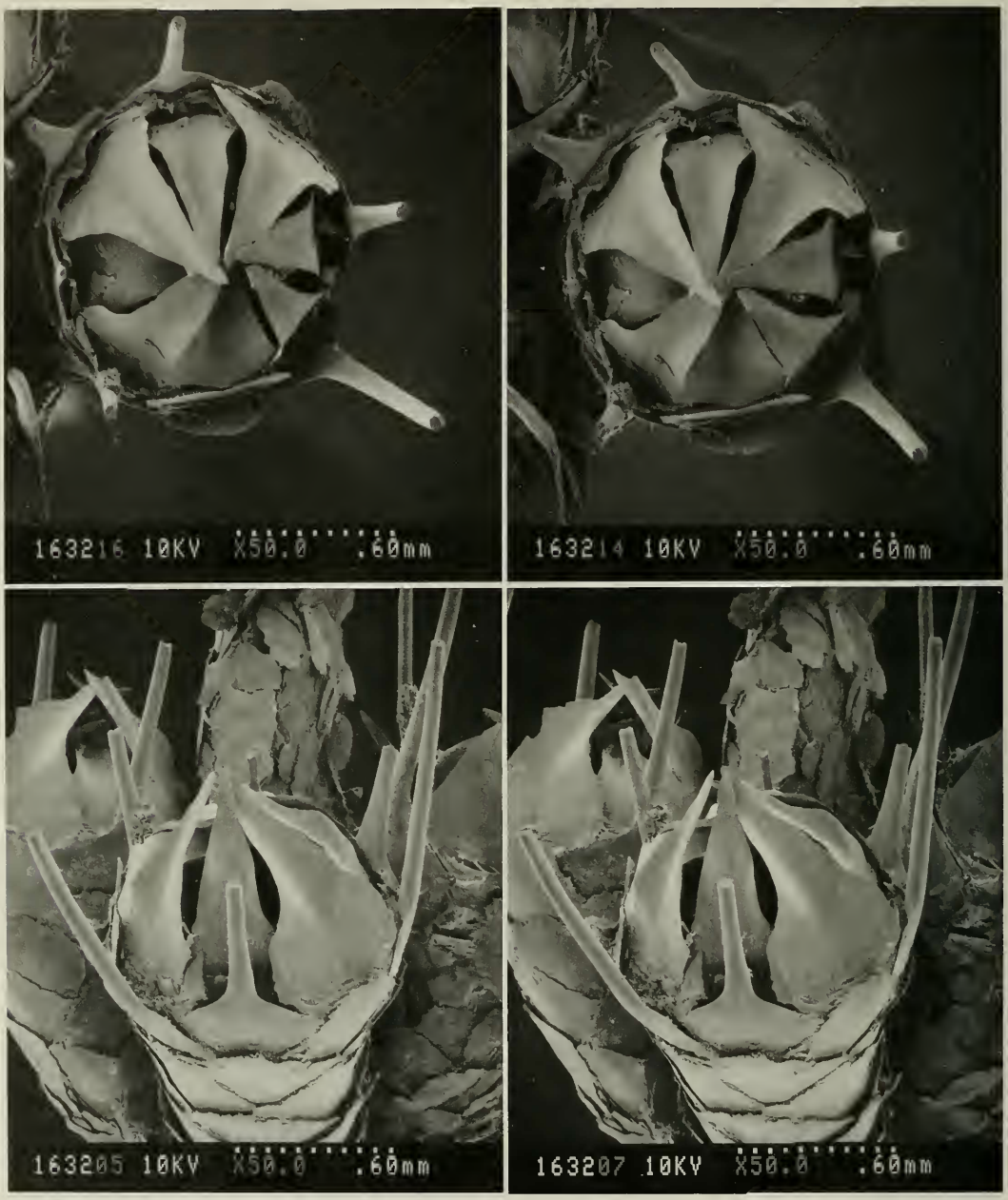


Fig. 4. *Callozostron mirabile* Wright, USNM 85294. Top, Oral view of polyp showing opercular scales in closed position; Bottom, Oblique view of polyp with opercular scales in closed position. Stereoscopic pairs (SEM 1632).

haenica Studer, and *Ophidiogorgia paradoxa* Bayer have been similarly stripped from their supporting axes, this circumstance seems not to be rare among unbranched primnoids.

Callozostron mirabile appears to be widely distributed around Antarctica. The type locality is off the Leopold & Astrid Coast of Princess Elizabeth Land at 65°42′00″S, 79°49′00″E in 3036 m. It also

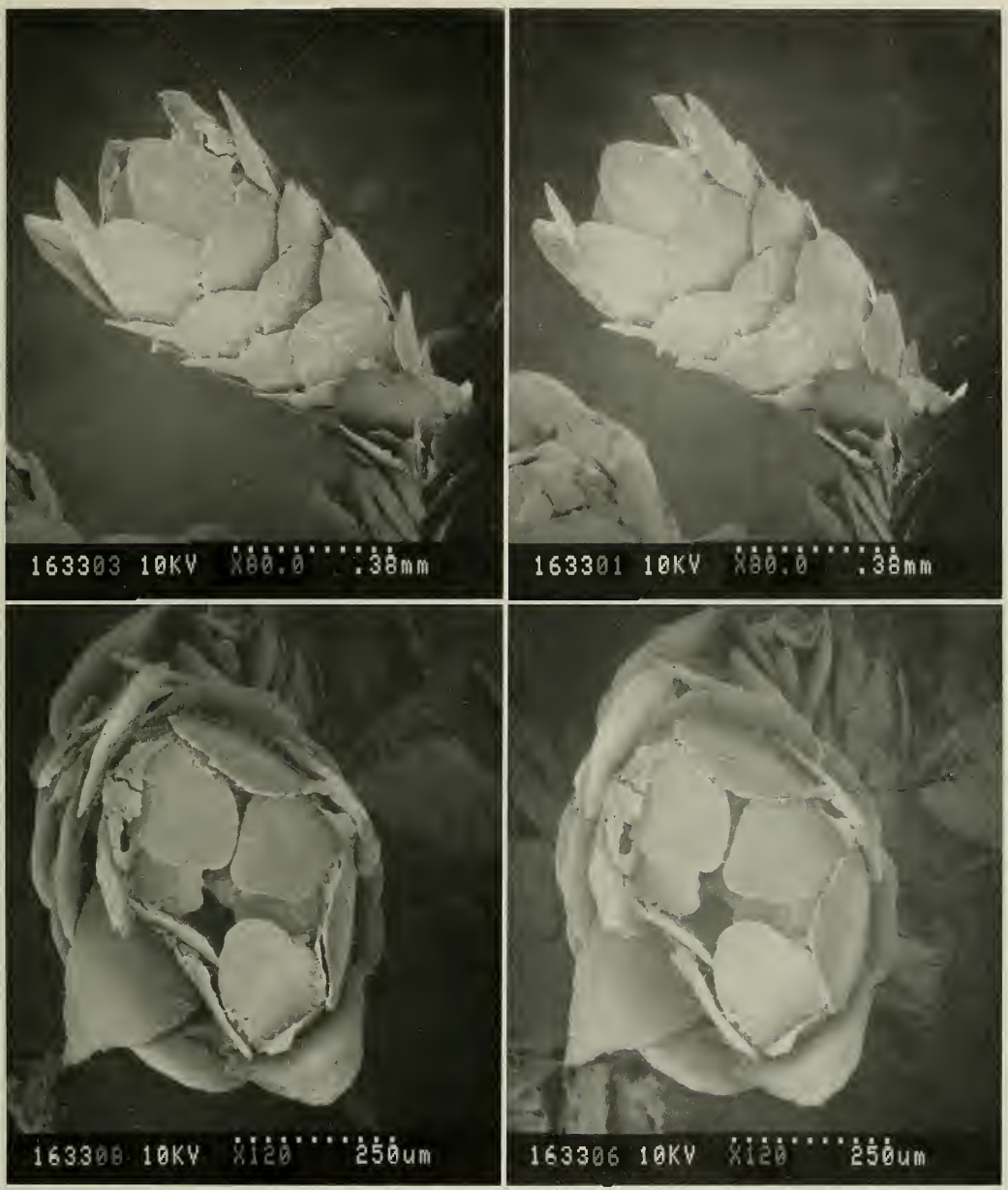
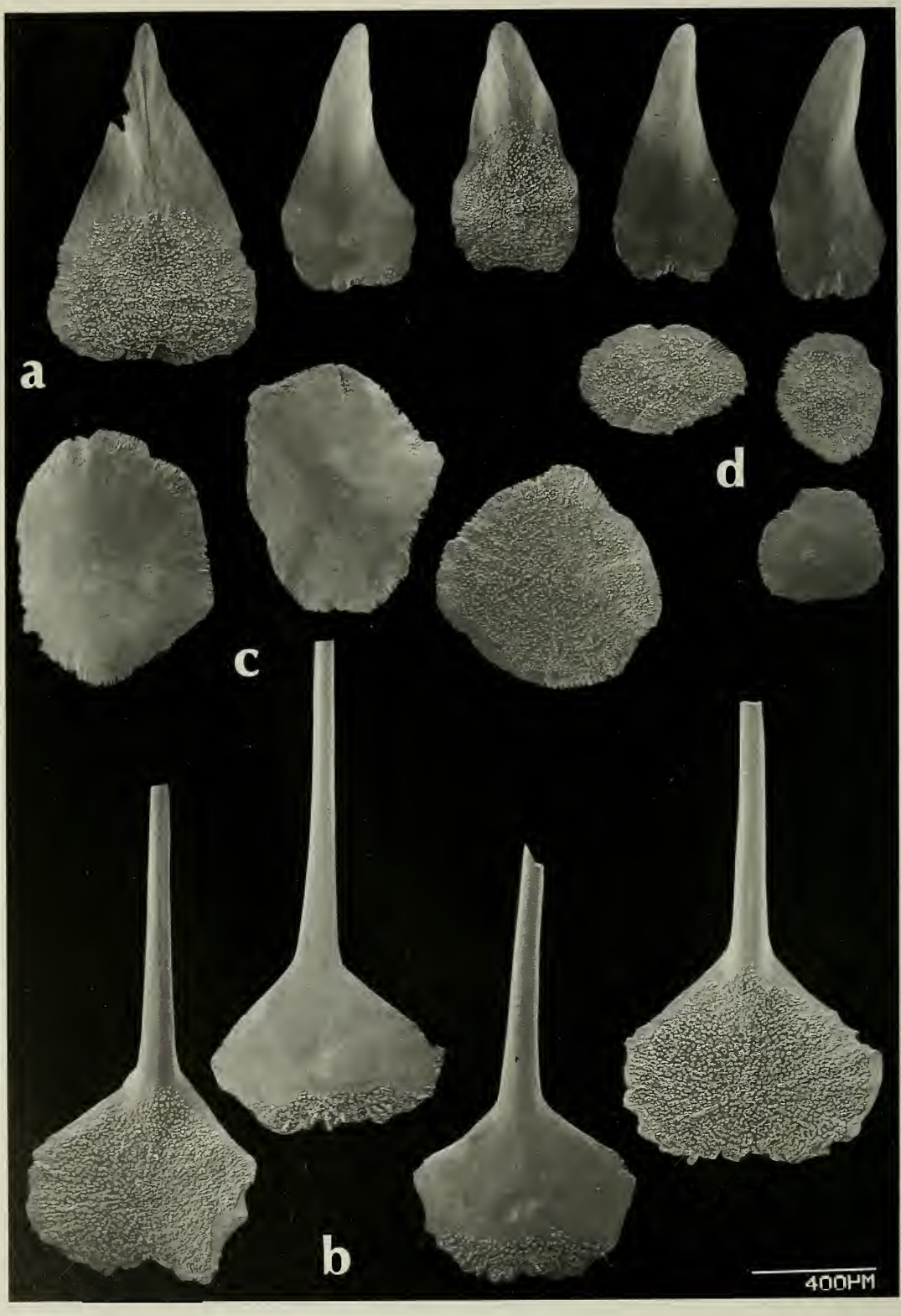


Fig. 5. *Callozostron mirabile* Wright, USNM 85294. Lateral and oral views of young polyp before differentiation of marginal and opercular scales. Stereoscopic pairs (SEM 1633).

has been taken by USNS *Eltanin* in the vicinity of the Balleny Islands off Wilkes Land, 64°59′S, 160°36′E, in 2536–2864 m; off the Antipodes Is., New Zealand, at 49°40′S, 178°56′E, in 952–1336 m; by R/V *Islas Orcadas* at 2 stations in the Scotia Sea at 2653–2941 m and 3819–3876 m, and 2 stations off South Sandwich Is. at 224–2402 m and 415–462 m. The unusually shallow depth of the specimen from sta. 52 (USNM 77339) is suspect, because it immediately followed sta. 51 of the same date


a
b
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in 2248–2402 m (USNM 82876) and probably was obtained with the same Blake trawl. The probability of contamination in sta. 52 of fragments from sta. 51 must be considered sufficiently strong to discount the anomalous bathymetric record.

Callozostron carlottae Kükenthal, 1909
Figs. 7, top; 8–10

Callozostron carlottae Kükenthal, 1909:49; 1912:334, figs. 43–47, 53, 54, pl. 22, figs. 14–17; 1919:451; 1924:307, fig. 168.—Schimbke, 1914:25.

Material.—Antarctic Ocean, off South Orkney Islands: 61°04′S, 39°55′W, 2355–2897 m, USNS *Eltanin* sta. 1545, 11 Feb 1966. 2 bifurcate colonies lacking holdfast, and 1 simple branch, USNM 77387. (SEM 1626, 1627.)

Diagnosis.—Flagelliform or bifurcate *Callozostron* with polyps in whorls of 8 or 9, having 2 rings of 8 scales (marginal and submarginal) surrounding the operculum, most or all with a stout apical spine; basal fusion of polyps negligible.

Comparisons.—This species superficially resembles *Callozostron diplodiadema* new species, but the polyps are shorter and the spines of the marginal and submarginal scales are shorter, stouter, distinctly tapered and prismatic in section.

Remarks.—The specimens here recorded agree with the type material of *C. carlottae* insofar as the ambiguities of the original description allow, except in growth form. The type specimen (Kükenthal 1912) was flagelliform and showed no evidence of branching, but two of the three colonies in the present collection are bifurcate immediately above the holdfast (Fig. 7, top) and the third is a single flagelliform branch that could be half of a bifurcate colony. Superficially, an unbranched colony would closely resemble a stout colony of *Primnoella magelhaenica* Studer, 1879 (cf. Figs. 20, 21).

Polyps are arranged in regular whorls (Fig. 8, top) of 9 (in the original type material mostly 8, but 9 in the median whorls, an insignificant difference); their overall height in the present material (Fig. 9) is about 2.5 mm (2.3–2.7 mm), of which a little more than 0.5 mm consists of the projecting marginal spines, compared with 1.2 mm overall as given by Kükenthal (1912: 335). The discrepancy may be explained by a difference in the way measurements were made but this cannot be verified as neither magnification nor scale accompanies Kükenthal's illustrations (1912: figs. 43, 53). In shape, the polyps (Fig. 9) are strikingly similar to Kükenthal's drawing (1912: fig. 43), with a double ring of strong spines surrounding the operculum (Fig. 8, bottom). Basal fusion of polyps is no more than occurs in *Primnoella magelhaenica* (cf. Fig. 24).

The sclerites are of the usual primnoid form, but somewhat thicker than in *Callozostron mirabile.* The body scales are broadly oval (Fig. 10c), and the opercular scales (Fig. 10a) diminish in size toward the adaxial side more than is the case in *mirabile.* The apical spine of the marginal and submarginal scales is marked by a few smooth longitudinal ridges (Fig. 10b). Although Kükenthal stated that numerous warts cover the surface of the lower part of the marginal scales, it is not clear whether he referred to the outer surface, the inner surface, or both. In primnoids, the inner surface of sclerites is invariably covered with complex warts, but the outer surface varies according to species and/or location. His illustration of a marginal scale (1912: fig. 44) appears to show the inner surface, leaving the nature of the outer surface un-

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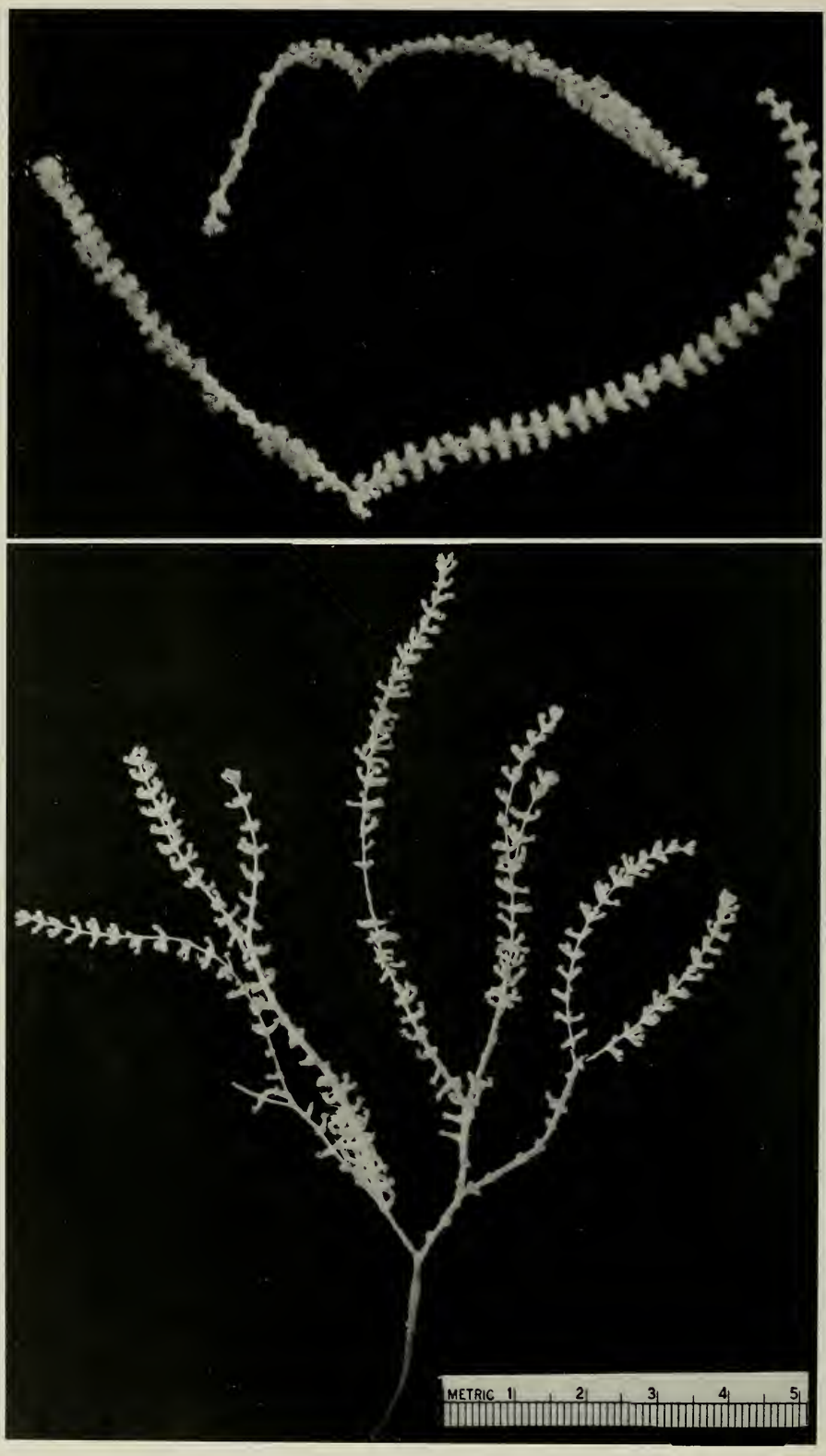
Fig. 6. *Callozostron mirabile* Wright, USNM 85294. Sclerites (SEM 1634). a, Opercular scales; b, Marginal scales; c, Body scales; d, Coenenchymal scales.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specified. In the present material, the outer surface of the proximal part of both marginal and opercular scales is covered with simple granules (Fig. 10a, b) while that of the body scales is smooth except for the proximal edge (Fig. 10c).

Callozostron diplodiadema, new species
Figs. 1, right; 11–14

Material.—Scotia Sea, SW of South Georgia Island: 55°01′S, 39°55′W, 2886–3040 m, USNS *Eltanin* sta. 1537, 8 Feb 1966. 7+ colonies USNM 77386. (SEM 1628, 1655–57.)

Diagnosis.—Flagelliform *Callozostron* with polyps in distinct whorls of up to 14, having 2 rings of 8 scales (marginal and submarginal) surrounding the operculum, each with a long, smooth apical spine; basal fusion of polyps negligible.

Description.—The material consists of 7 incomplete colonies still with supporting axial skeleton, the longest of which is 19 cm in length lacking holdfast (Fig. 1, right), and 10 pieces of various size stripped off the axis during collection. It is likely that at least some of these pieces occupied naked spaces on some of the damaged colonies. One colony with axis nearly or quite intact apically is 9.7 cm long and attached by a small discoidal holdfast to a flat black pebble. The polyps stand almost perpendicular to the axis and are arranged in regular whorls (Figs. 11, 12), mostly of 9–12 but initially of 4 and ultimately as many as 14. Where the coenenchyme remains undisturbed on the axis, 4–5 whorls occur in 1 cm of length, but where artificially compressed along the axis or completely stripped from it, 7 whorls may be closely crowded in 1 cm of length.

The polyps are about 2 mm tall exclusive of the operculum and marginal spines (Fig. 12, bottom), only the basal part of their bodies fused together, the free distal half about 0.5 mm in diameter widening distally to about 0.8 mm at the level of the circumoperculum. The marginal (circumopercular) and submarginal scales each have a long, smooth, somewhat curved apical spine (Fig. 14b), together forming crown of 16 spines surrounding the operculum (Fig. 13, top). The operculum (Fig. 13, bottom) is composed of 8 tall, triangular scales of about equal size, with somewhat convex sides (Fig. 14a). The opercular scales are vertically aligned with the circumopercular and following longitudinal rows of body scales. The distal margin of some of the scales in the transverse row beneath the submarginals may be more or less acutely pointed but not produced as a spine (Fig. 14c). The abaxial and adaxial longitudinal rows of body scales consist of 5–6 scales each, including the spinous submarginals and circumoperculars. Their outer surface is smooth and glossy, the inner surface covered by complex tubercles where embedded in the body wall (Fig. 14d). The coenenchymal sclerites (Fig. 14e) are rounded scales smaller than those of the polyps. The tentacles are devoid of sclerites. No irregularly tuberculate sclerites are present in the walls separating the longitudinal stem canals.

Comparisons.—This species superficially resembles *C. carlottae* but the polyps are taller and the spines of the marginal and submarginal scales are much longer, smooth, cylindrical or elliptical in cross section.

Etymology.—Greek διπλόος, double + διάδημα, diadem, crown. Noun in apposition.

Callozostron acanthodes, new species
Fig. 7, bottom; 15–17

Material.—East of North Island, New Zealand, 38°24′S, 178°53′E, 1354–1995 m,

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Fig. 7. Top, *Callozostron carlottae* Kükenthal, two bifurcate colonies, USNM 77387; Bottom, *Callozostron acanthodes,* holotype, USNM 94575.

Fig. 8. *Callozostron carlottae* Kükenthal, USNM 77387. Top, Part of branch showing two whorls of polyps (SEM 1626); Bottom, Oral view of polyp (SEM 1627). Stereoscopic pairs.

USNS sta 1712, 5-foot Blake trawl 40 minutes at depth, 28 May 1966. One colony with branches detached, USNM 94575. (SEM 1594, 1595, 1603, 1617, 1618.)

Diagnosis.—Dichotomously branched *Callozostron* with tall, slender polyps arranged in widely spaced whorls commonly of 5, sometimes 6, rarely isolated; usually

4 whorls in 1 cm; individuals often partly united basally as pairs. Marginal scales with extremely long, slender spine, vertically aligned with opercular scales; apex of opercular scales prolonged as a slender, acute spine.

Description.—The holotype colony (Fig. 7, bottom) is sparsely dichotomously branched in one plane, 11 cm tall lacking the holdfast and perhaps the uppermost terminal twig; undivided terminal twigs to 5 cm in length. The axis is calcified, light brown with little or no luster in the main stem, cylindrical, smooth, 0.9 mm in diameter, becoming paler distad; in the terminal branches it is cream white with moderate pearly luster, proximally about 0.5 mm in greater diameter, flattened in the plane of branching, tapering distad to an extremely fine tip.

The polyps are situated in widely spaced whorls of 3–6, commonly 5 (Fig. 15); usually 4 whorls in 1 cm except at the tips of branches where there may be 5. The distalmost whorl consists of 2–4 polyps, new polyps arising within whorls proximad. Nowhere in the colony is there any evidence of new whorls of polyps originating between fully developed whorls, indicating that growth is exclusively terminal. Rarely a single polyp occurs in the location of a whorl.

Fully developed polyps (Fig. 15, bottom) are about 2.5 mm tall and 0.5 mm in diameter, nearly cylindrical, somewhat flared immediately below the tentacles, and inclined slightly distad. Adjacent polyps may be proximally somewhat fused to form pairs (Fig. 16, top). They are covered by roughly fanshaped scales aligned in more or less distinct longitudinal rows consisting of about 10 scales. The body scales (Fig. 17a) are externally smooth, internally sculptured with scattered complex tubercles; their distal free margins are irregularly serrate. Several of the marginal scales (Fig. 17b) have an extremely long, slender apical spine that may exceed 3 mm in length; the spine usually is smooth, but in some cases shows traces of widely scattered, low, simple granules. Owing to their extreme delicacy, none of the marginal scales were preserved with spine intact, so their greatest length cannot be determined. The operculum (Fig. 16, bottom) consists of eight ovate scales with the distal margin smooth and apically extended as a smooth, slender spine (Fig. 17c).

The coenenchyme is thin, covered by small, externally smooth, rounded scales (Fig. 17d).

Comparisons.—*Callozostron acanthodes* new species differs sharply from previously known species by its openly dichotomous branching, the wide spacing of the whorls, and the conspicuous apical spine of the of the opercular scales.

Etymology.—Greek ακανθώδης, thorny.

Remarks.—This species is assigned to the genus *Callozostron* because of the regular verticillate arrangement of the polyps, clear differentiation of opercular from marginal scales, spinelike apical projection of the marginal scales, and regular rows of body scales. The branched colonial form is not considered an exclusive character as it is here shown that colonies of *C. carlottae* may be bifurcate. The polyps bear some resemblance to those of *Mirostenella* Bayer, 1988, but are proportionally much taller, with several but not all of the marginal scales furnished with a strong apical spine.

Discussion.—If the tendency toward proximal fusion of polyps in *Callozostron acanthodes* is disregarded, the species cannot be aligned with any valid genus recognized in the keys of Kükenthal (1915, 1919, 1924), and Bayer (1981). No genus having verticillate polyps with 8 marginal scales vertically aligned with the 8 opercular scales, as in *Mirostenella,* had been described. Although the sclerites of the polyps of *Plumarella* meet these qualifications, the polyps of that genus are not arranged in whorls. In *Mirostenella,* all 8 marginal scales have an acute apex or short spine; in *Callozostron,* as few as 4 or as


162705 5.0KV X20.0 1.50mm
162707 5.0KV X20.0 1.50mm
162713 5.0KV X30.0 1.00mm
162715 5.0KV X30.0 1.00mm

many as 8 marginal scales are prolonged as spines, but when all 8 are spinous (*carlottae, diplodiadema*), the next one or two circles of body scales below the marginals also are spinous.

Primnoella Gray

Primnoella Gray, 1858:286; 1870:49.—Studer [& Wright], 1887:51 (part).—Wright & Studer, 1889:87 (part: B. "Carinatae").—Versluys, 1906:48, 52 (part: Carinatae).—Kükenthal 1907:210.—Aurivillius, 1931:267.—Deichmann, 1936: 162.—Bayer, 1956:F220 (part); 1981:936 (part; in key only).—Broch, 1965:20 (part).—Bayer & Stefani, 1989:455 (part; in key only).

Primnoella "Compressae" Kükenthal, 1908:13; 1912:311; 1915:148; 1919:384; 1924:279.

Type species.—*Primnoa australasiae* Gray, 1850, by monotypy.

Diagnosis.—Flagelliform, unbranched or sparsely branched primnoids with polyps arranged in whorls, directed strongly upward, often appressed to axial cortex but never adnate; opercular scales decreasing in size toward axis, distinctly differentiated from, and more or less overreached by, marginal (i.e., "circumopercular") scales; body of polyps compressed, with two longitudinal abaxial rows of wide imbricating scales, outer lateral and inner lateral rows reduced in size and numbers; adaxial surface either naked except for at most a few small scales below the marginals, or with small, delicate scales arranged in two more or less complete longitudinal rows. Surface of coenenchyme covered with rounded or polygonal scales; walls of longitudinal stem canals with irregular, tuberculate sclerites.

Remarks.—The genus *Primnoella* Gray, 1858, was based upon *Primnoa australasiae* Gray, 1850, syntypes of which are still preserved dry in The Natural History Museum, London (Reg. nos. BMNH 1850.1.21.1, 6 and 10; 1983.3.2.13 and 14).

Species groups within Primnoella sensu lato.—As heretofore defined, the genus *Primnoella* comprises two groups of species having polyps of distinctly different morphological types with respect to form and spiculation. In one group including the type species, designated "Carinatae" by Wright & Studer (1889:87) and later "Compressae" by Kükenthal (1908:13), the polyps are directed strongly upward, more or less closely appressed to the coenenchyme, with two longitudinal rows of large abaxial scales, reduced outer and inner lateral scale rows, and their adaxial surface more or less naked and mostly devoid of sclerites below the marginals. In the other group, designated "Convexae," which includes *P. magelhaenica,* the polyps are curved inward less strongly if at all, there are four longitudinal rows of abaxial scales and well developed inner lateral and adaxial rows of scales so their adaxial surface is completely covered by sclerites.

Although the polyps of some species of the Convexae group of *Primnoella* have fewer scales in the adaxial sclerite rows than in the abaxial rows, the adaxial side of the body nevertheless is completely covered by scales even if it is somewhat shorter than the abaxial side. There is no naked or nearly naked adaxial tract like that of all species of the Compressae group. Therefore, species of the Convexae group are separated from those of the Compressae group by a morphological discontinuity much more distinct and consistent than that separating many other related genus-group taxa in this and other families of Gorgonacea. This discontinuity justifies the recognition of the

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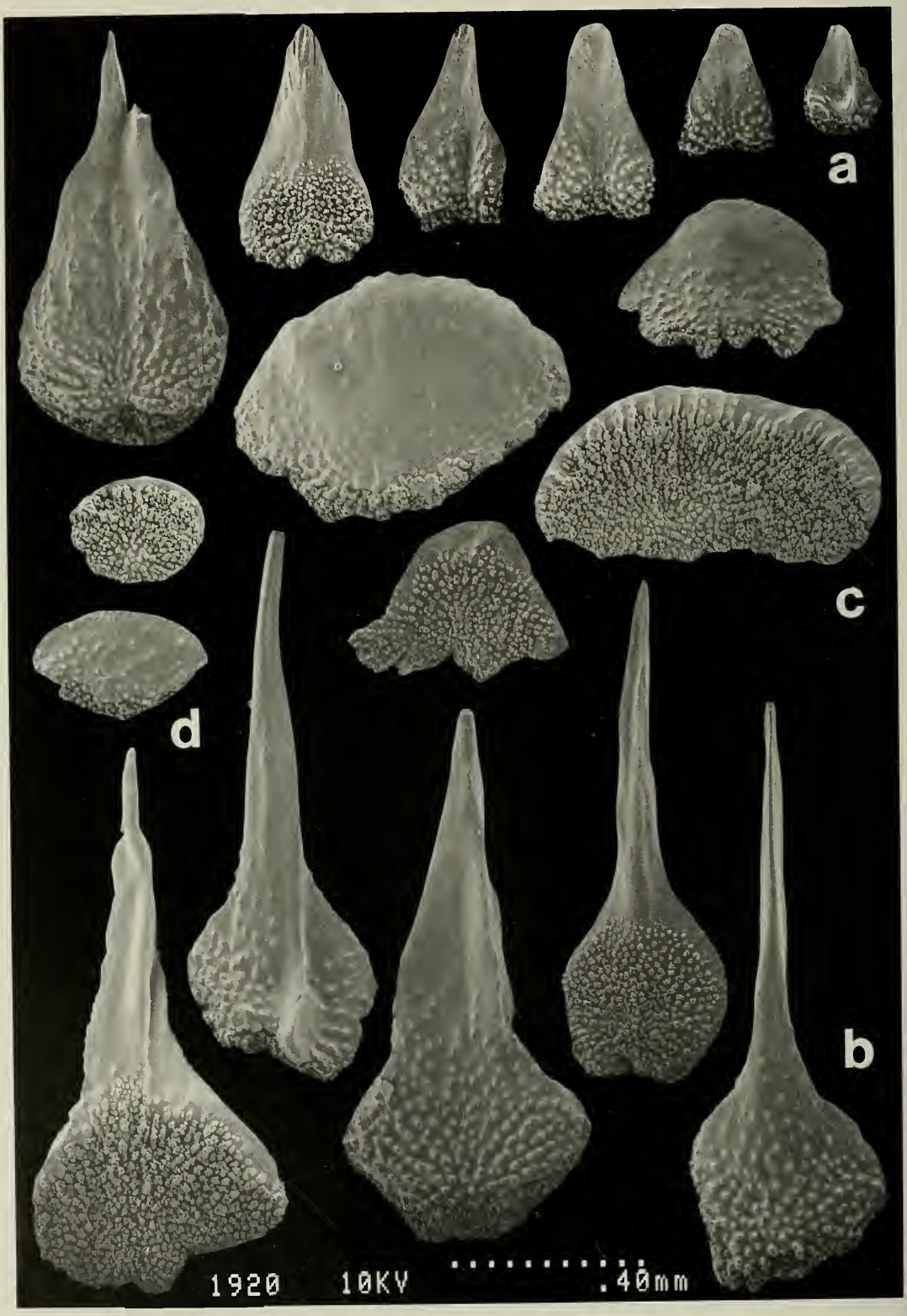
Fig. 9. *Callozostron carlottae* Kükenthal, USNM 77387. Part of one whorl. Top, Three polyps seen from below; Middle, Three polyps seen from above; Bottom, Detail of two polyps. Stereoscopic pairs (SEM 1627).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Convexae group of species as a genus distinct from the Compressae group.

Inasmuch as no genus-group name has heretofore been established for any species of the Convexae group, the name *Convexella* is now proposed for them as a distinct taxon, with *Primnoella magelhaenica* as type species.

Distribution of Primnoella "Compressae."—The genus *Primnoella* as now restricted is most richly represented in Antarctic and sub-Antarctic waters, with relatively few species in temperate and tropical waters of the Atlantic, Pacific and Indian oceans. It is represented in the northern hemisphere by only one species, *P. polita* Deichmann, 1936.

Species.—Kükenthal (1924:280) assigned 7 species to the "Compressae" group: *P. scotiae* Thomson & Ritchie, 1906; *compressa* Kükenthal, 1908; *biserialis* Wright & Studer, 1889; *australasiae* (Gray, 1850); *delicatissima* Kükenthal, 1909; and *grandisquamis* Wright & Studer, 1889. To these may now be added *P. polita* Deichmann, 1936. As demonstrated below, *Caligorgia* (sic) *gracilis* Thomson & Mackinnon can also be assigned to *Primnoella* rather than to *Callogorgia.*

Primnoella australasiae (Gray, 1850)
Figs. 18, 19

Primnoa australasiae Gray, 1850a:146, Radiata pl. 2, figs. 8, 9; 1850b:510.

Primnoella australasiae.—1858:286; 1859: 483; 1870:50.—Wright & Studer, 1889: 88, pl. 18, figs. 1, 1a; pl. 21, fig. 15.—Versluys, 1906:52.—Thomson & Mackinnon, 1911:688, pl. 61, fig. 1.—Kükenthal, 1919:401, pl. 41, figs. 62, 63.

Material examined.—D'Entrecaseaux Channel, between Tasmania and Bruce's Island. (Gray, teste Joseph Millingin, F. L. S. Syntypes, The Natural History Museum, London, register nos. 1850.1.21.1, 6 and 10; 1983.3.2.13 and 14 (SEM 1936-1938). D'Entrecasteaux Channel (43°17'S, 147°15'E), near Kinghorne Point, Bruny Island, Tasmania, 15 m, coll. A. J. Blackman, 1979. One colony, USNM 58926 (SEM 485, 487). Bluff Harbor, South Island, New Zealand (46°34'S, 168°20'E), coll. Dr. E. Kershner, January 1875. 30 colonies, dry, USNM 4505 (SEM 505).

Discussion.—Robust, flagelliform colonies up to 1 m tall have 5–8 whorls of 13–15 strongly appressed polyps of the "Compressae" type in 1 cm of axial length. Only the two abaxial sclerite rows are fully visible and contain 10–14 scales each; the outer lateral rows each consist of about the same number of scales but they are smaller and because of their position only their edes are visible. The inner lateral rows each contain at least 5 or 6 scales, still smaller than those of the outer lateral rows. The walls of the longitudinal stem canals are filled with irregularly tuberculate sclerites of extremely diverse shape.

The dry specimens here reported from Bluff Harbor, New Zealand (Fig. 19, right) resemble Gray's type material (Fig. 18) from D'Entrecasteaux Channel, Tasmania. The colonies are attached by discoidal holdfasts to the dead shells of pectinid bivalves, as many as 7 to a single shell, and reach a height of approximately 1 m. In some colonies, the proximal 3 or 4 scales of the abaxial rows are somewhat larger than those located more distally, and there is evidence that this may be related to the presence of eggs or embryos in the gastrovascular cavities. Although this condition was not noticed in the type specimens (Fig. 18), it was not specially looked for among the numerous dry specimens.

The polyps of the topotypic colony from

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Fig. 10. *Callozostron carlottae* Kükenthal, USNM 77387. Sclerites (SEM 1920). a, Opercular scales; b, Marginal scales; c, Body scales; d, Coenenchymal scales.

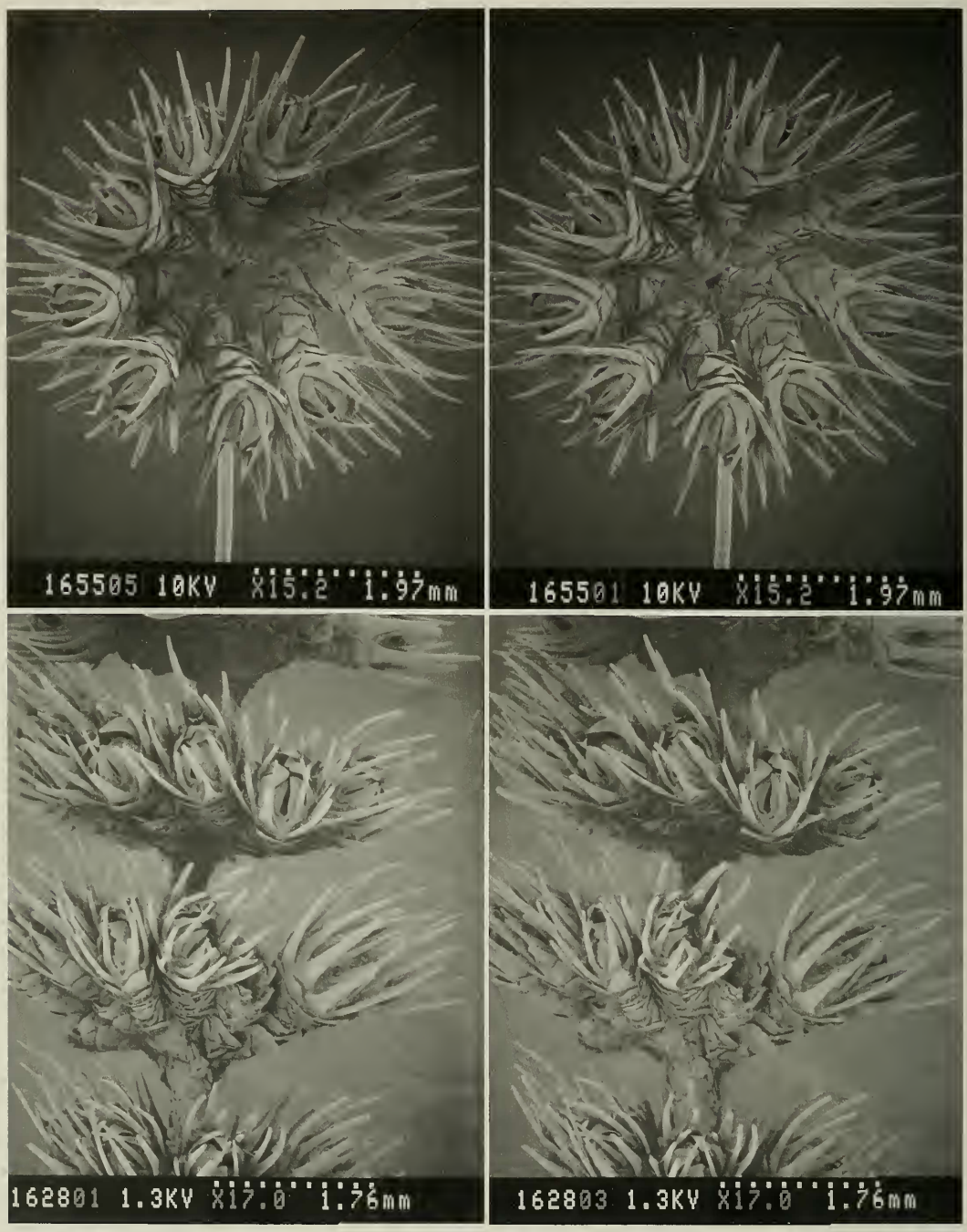


Fig. 11. *Callozostron diplodiadema,* new species, USNM 77386. Top, Complete whorl seen from above (SEM 1655); Bottom, Two whorls from the side (SEM 1628). Stereoscopic pairs.

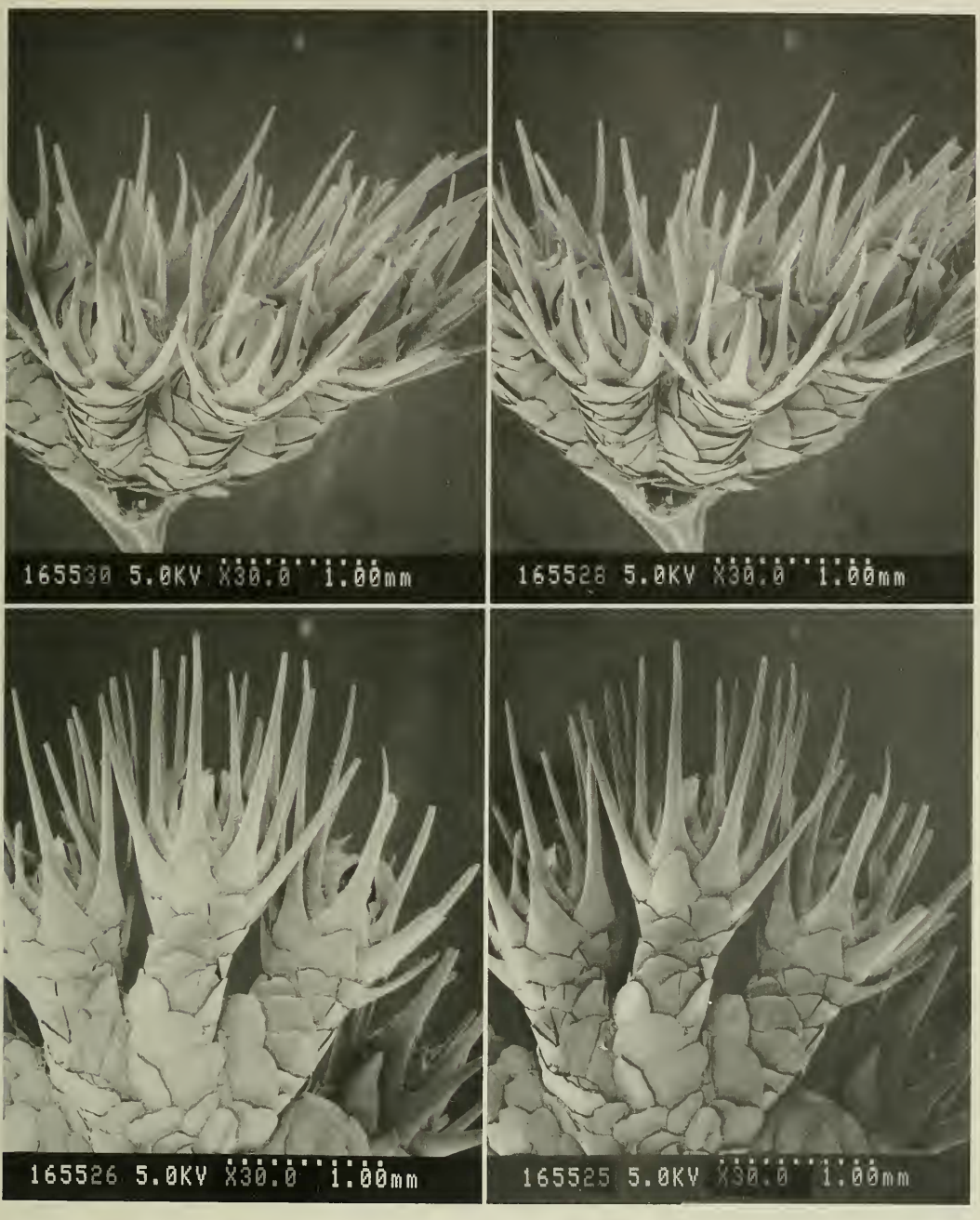


Fig. 12. *Callozostron diplodiadema,* new species, USNM 77386. Top, Part of whorl, side view; Bottom, Detail of polyps. Stereoscopic pairs (SEM 1655).

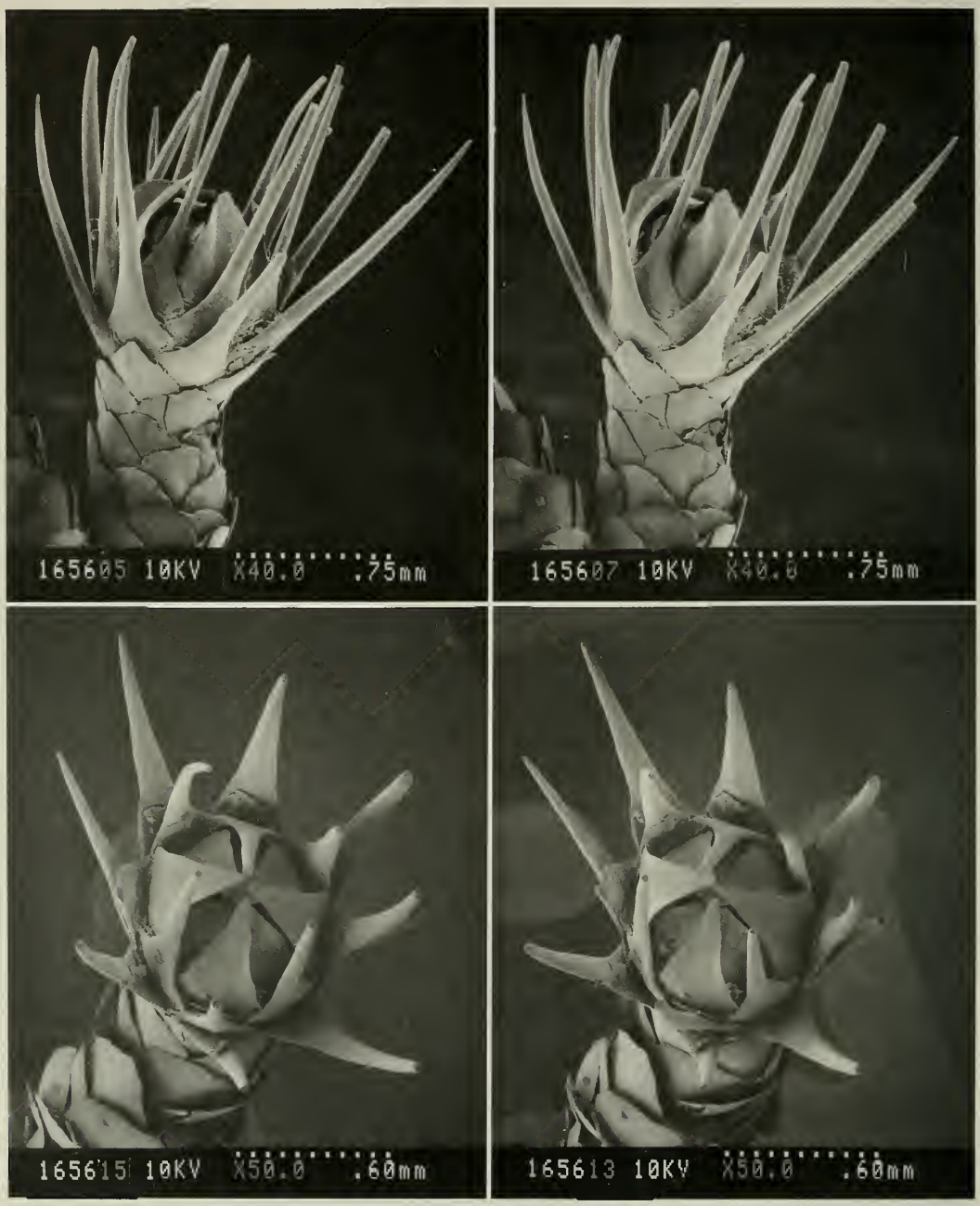


Fig. 13. *Callozostron diplodiadema,* new species, USNM 77386. Detail of polyp. Top, Side view; Bottom, Oral view. Stereoscopic pairs (SEM 1656).

Tasmania (Fig. 19, left) are somewhat more slender than those of either the type specimens examined or the colony from New Zealand and could be associated with the reproductive condition of the colony. The adaxial scales of this specimen preserved in alcohol seem not so closely fitted as in the two lots of dried specimens.

The specimens sent to Gray were "covered with a calcareous coat of a cream-yellow colour" (Gray, 1850:147). The illustration given by Thomson & Mackinnon (1911; pl. 61, fig. 1) gives a fair idea of the appearance of the whorls.

Primnoella laevis
(Thomson & Mackinnon, 1911)
Fig. 20

Caligorgia laevis Thomson & Mackinnon, 1911:689, pl. 65, fig. 1; pl. 68, fig. 7; pl. 80.—Kükenthal, 1919:377; 1924:275, fig. 155.

Callogorgia laevis.—Bayer, 1982:122 (in key only; removed from *Callogorgia* and referred to *Primnoella* in footnote, but new combination was not actually printed there).

Material examined.—Syntypes (Australian Museum, Sydney).

Description.—See Thomson & Mackinnon, 1911:689.

Distribution.—Coast of New South Wales.

Remarks.—While on a brief visit to the Australian Museum, I was able to examine Thomson & Mackinnon's original material through the kindness of Dr. Pat Hutchings. As can be seen from the photograph of a specimen reproduced by Thomson & Mackinnon (1911:pl. 80), the branching of the colony is spare and open rather than "luxuriant" as described by Thomson & Mackinnon. Even the rather crude drawing of a single polyp given by Thomson & Mackinnon (1911:pl. 55, fig. 1) is adequate to demonstrate that the species does not belong to "*Caligorgia*" (= *Callogorgia*). Although the polyps (Fig. 38) are arranged in whorls as usual in both *Callogorgia* and *Primnoella* and are directed obliquely upward and curved toward the coenenchyme, they do not face inward toward the axis as is usual in *Callogorgia,* and the body sclerites are not strongly sculptured externally as commonly is the case in *Callogorgia* (e.g., see Bayer 1982:figs. 2, 4).

Although *Primnoella divaricata* (Studer) and *P. divergens* Hickson are described as branched they are very sparsely so, whereas *P. laevis* is repeatedly branched in a dichotomous manner.

Convexella, new genus

Primnoella.—Studer [& Wright], 1887: 51.—Madsen, 1944:39.—Bayer, 1956: F220 (part).—Broch, 1965:20 (part).—Bayer, 1981:936 (part; in key only).—Bayer & Stefani, 1989:455 (part; in key only).

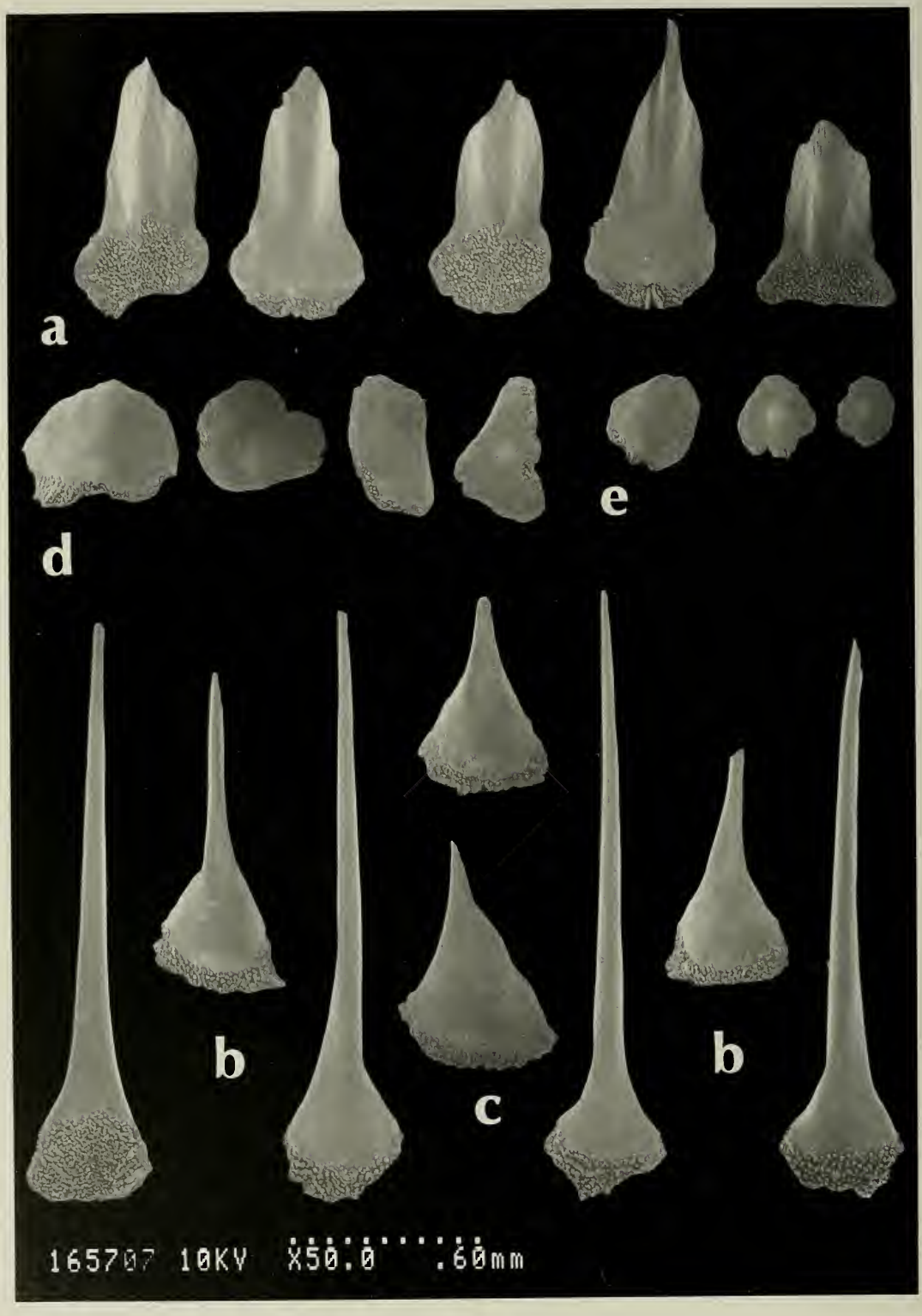
Primnoella Convexae.—Wright & Studer, 1889:83.—Versluys 1906:51.—Kükenthal, 1908:13; 1912:311; 1915:148; 1919: 384; 1924:279.

Type species.—*Primnoella magelhaenica* Studer, 1879, here designated.

Diagnosis.—Flagelliform, unbranched or sparsely branched primnoids with polyps arranged in whorls, standing almost vertically or directed more or less obliquely upward, not appressed to axial cortex; marginal and sometimes submarginal scales folding over opercular scales, which are more or less hidden and not clearly differentiated from marginals; body of polyps cylindrical and weakly curved, not compressed, abaxial surface covered by four longitudinal rows of rounded or oval imbricating scales, adaxial and lateral surfaces covered by inner-lateral and adaxial scales of similar size, in rows that may be somewhat shorter than the abaxial and outer-lateral rows. Surface of coenenchyme covered with rounded, imbricating scales; walls of longitudinal stem canals with irregular, tuberculate sclerites.

Remarks.—The type species is now illustrated extensively to demonstrate its variability and to show its similarities to *Callozostron,* without prematurely speculating upon phylogenetic relationships.

Species.—Kükenthal (1924:280) referred seven species to the "Convexae" group of *Primnoella: flagellum* Studer, 1879; *vanhoeffeni* Kükenthal, 1909; *magelhaenica*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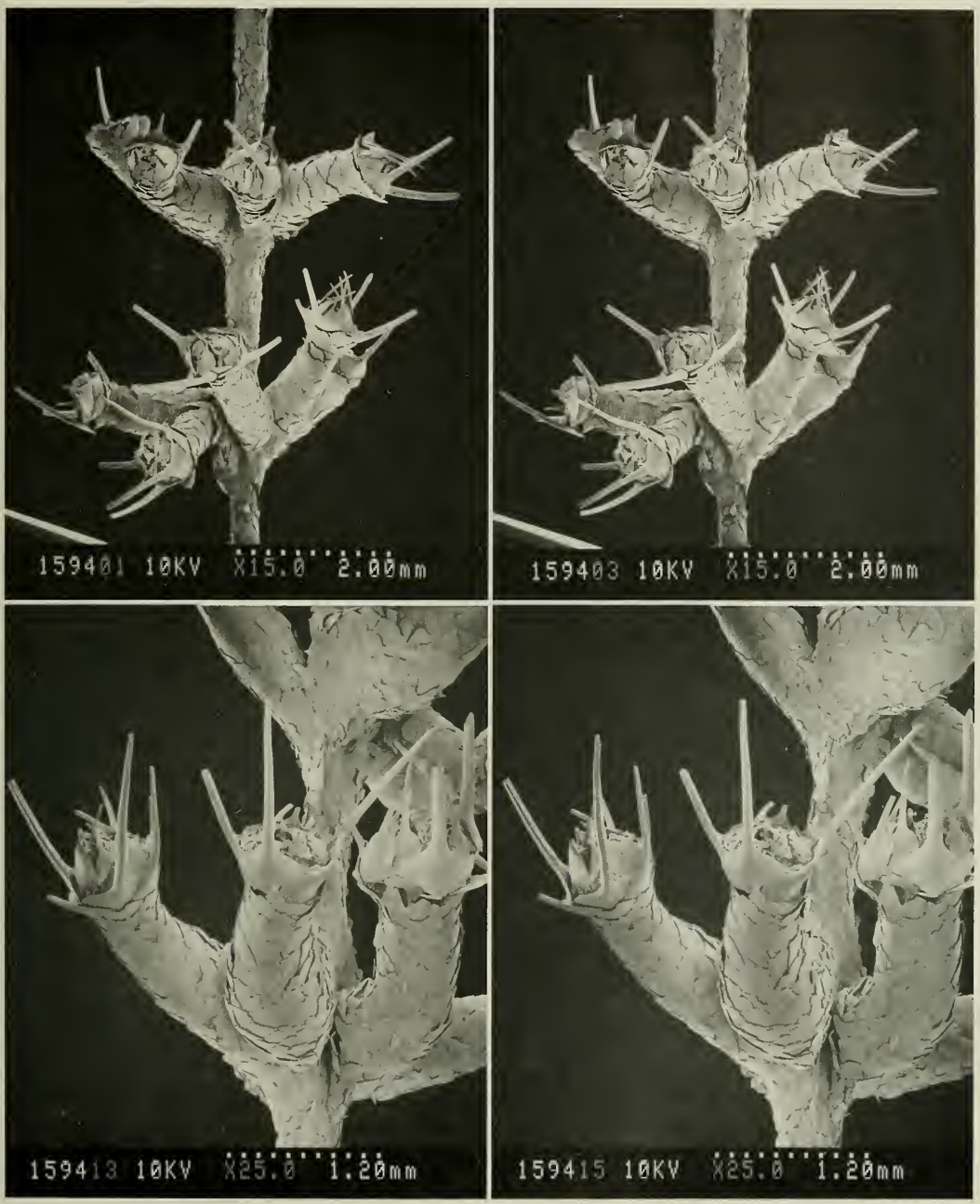

Fig. 15. *Callozostron acanthodes,* new species, USNM 94575. Top, Part of branch with two whorls of polyps; Bottom, Detail of whorl. Stereoscopic pairs (SEM 1594).

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Fig. 14. *Callozostron diplodiadema,* new species, USNM 77386. Sclerites (SEM 1657). a, Opercular scales; b, Marginal and submarginal scales; c, Body scales with acute apex; d, Body scales; e, Coenenchymal scales.

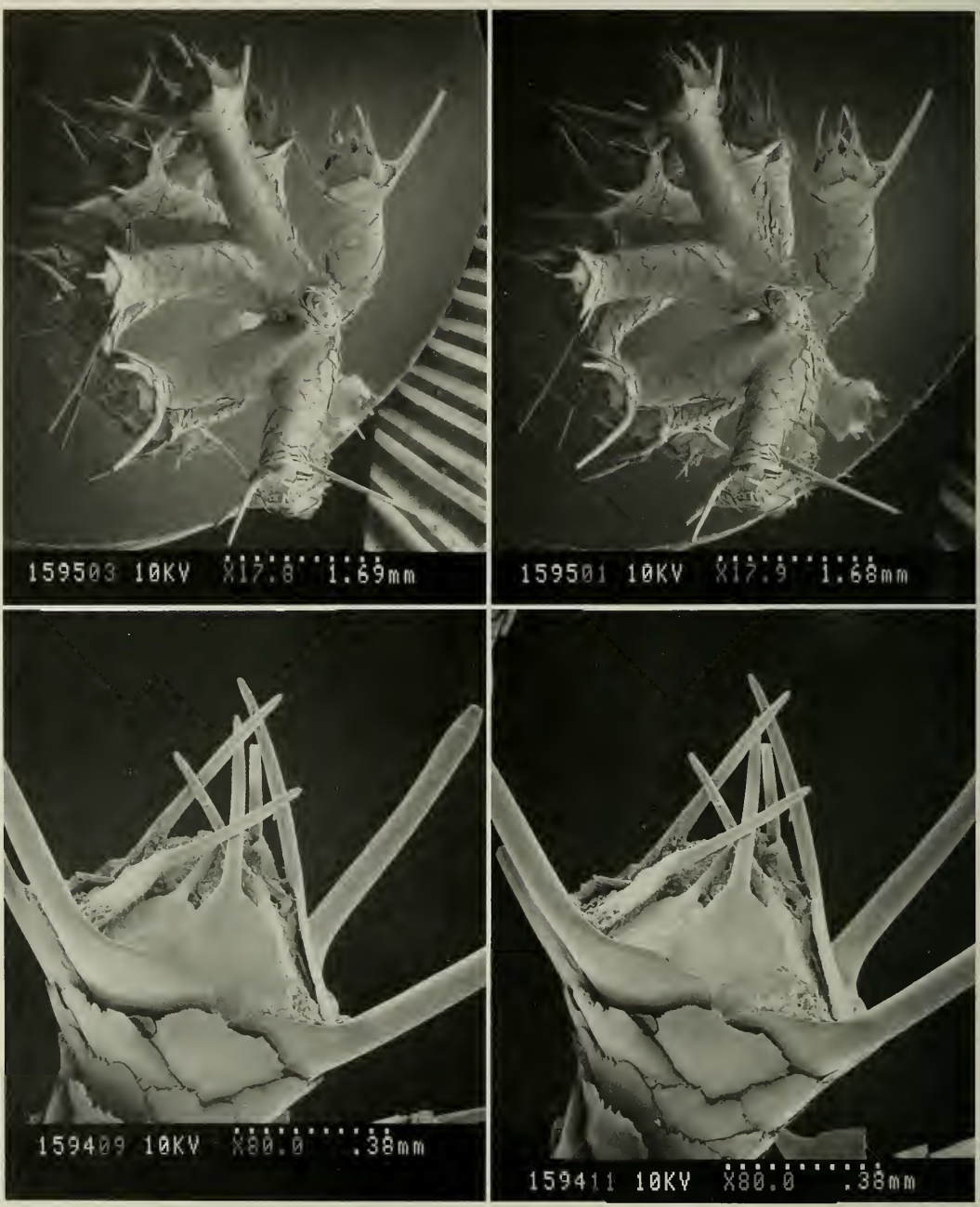


Fig. 16. *Callozostron acanthodes,* new species, USNM 94575. Top, Part of branch viewed from above, showing two pairs of basally united polyps (SEM 1595); Bottom, Distal end of polyp showing opercular scales in closed position (SEM 1594). Stereoscopic pairs.

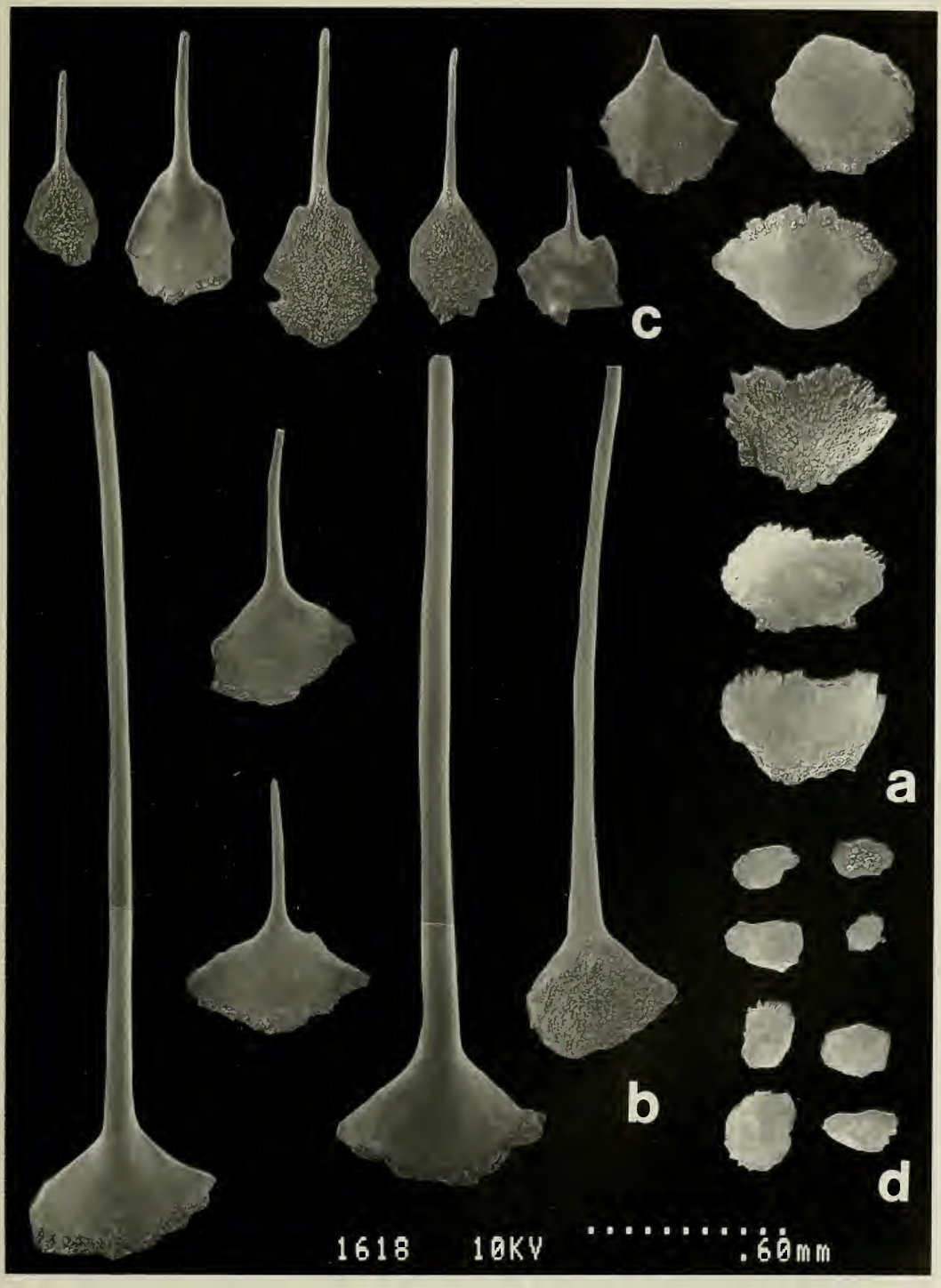


Fig. 17. *Callozostron acanthodes,* new species, USNM 94573. Sclerites (SEM 1618). A, Body scales; b, Marginal scales; c, Opercular scales; d, Coenenchymal scales.

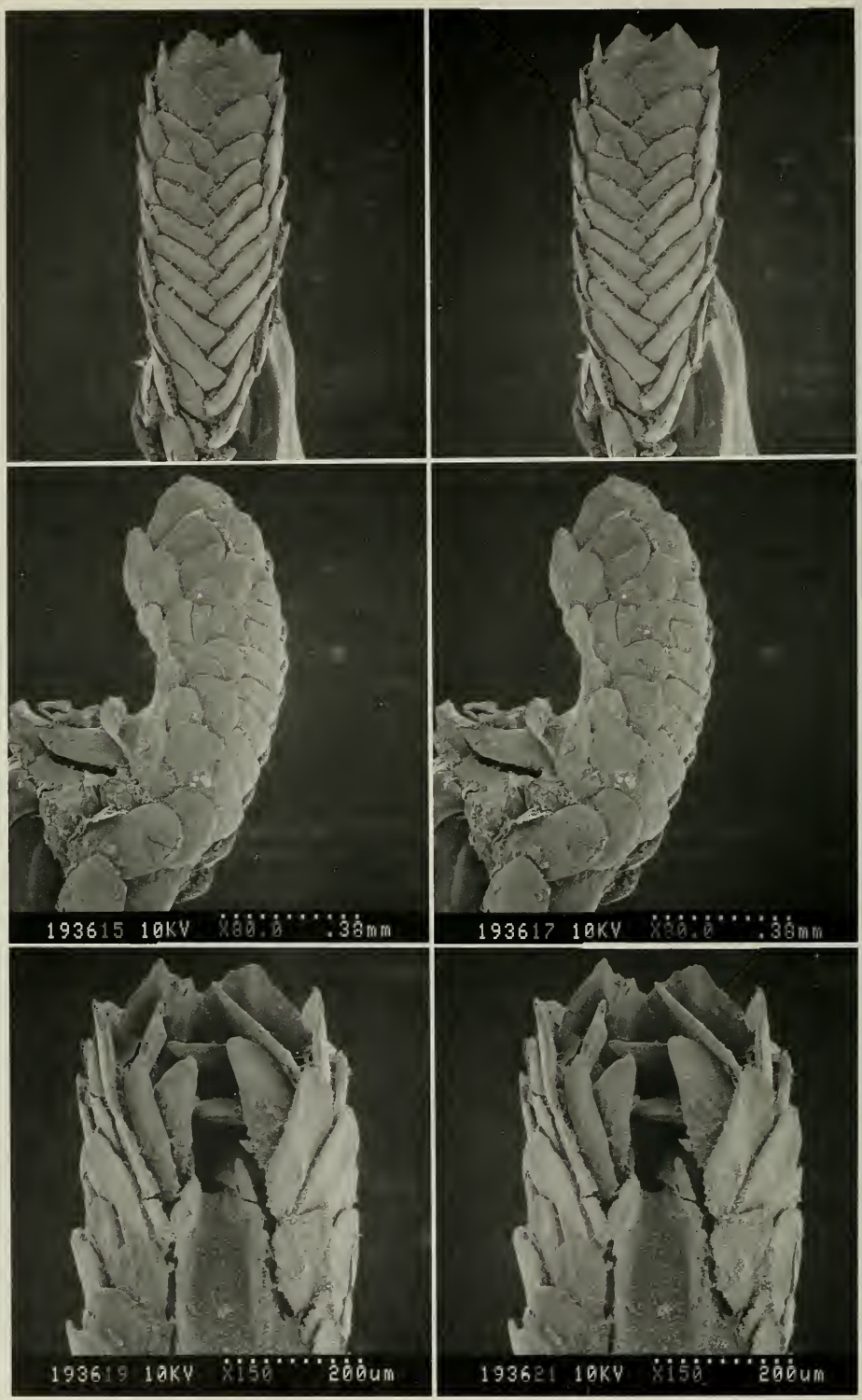


Fig. 18. *Primnoella australasiae* Gray, BM(NH) 1850.1.21.1/6/10. Isolated polyp in abaxial, lateral, and oral view. Stereoscopic pairs (SEM 1936).

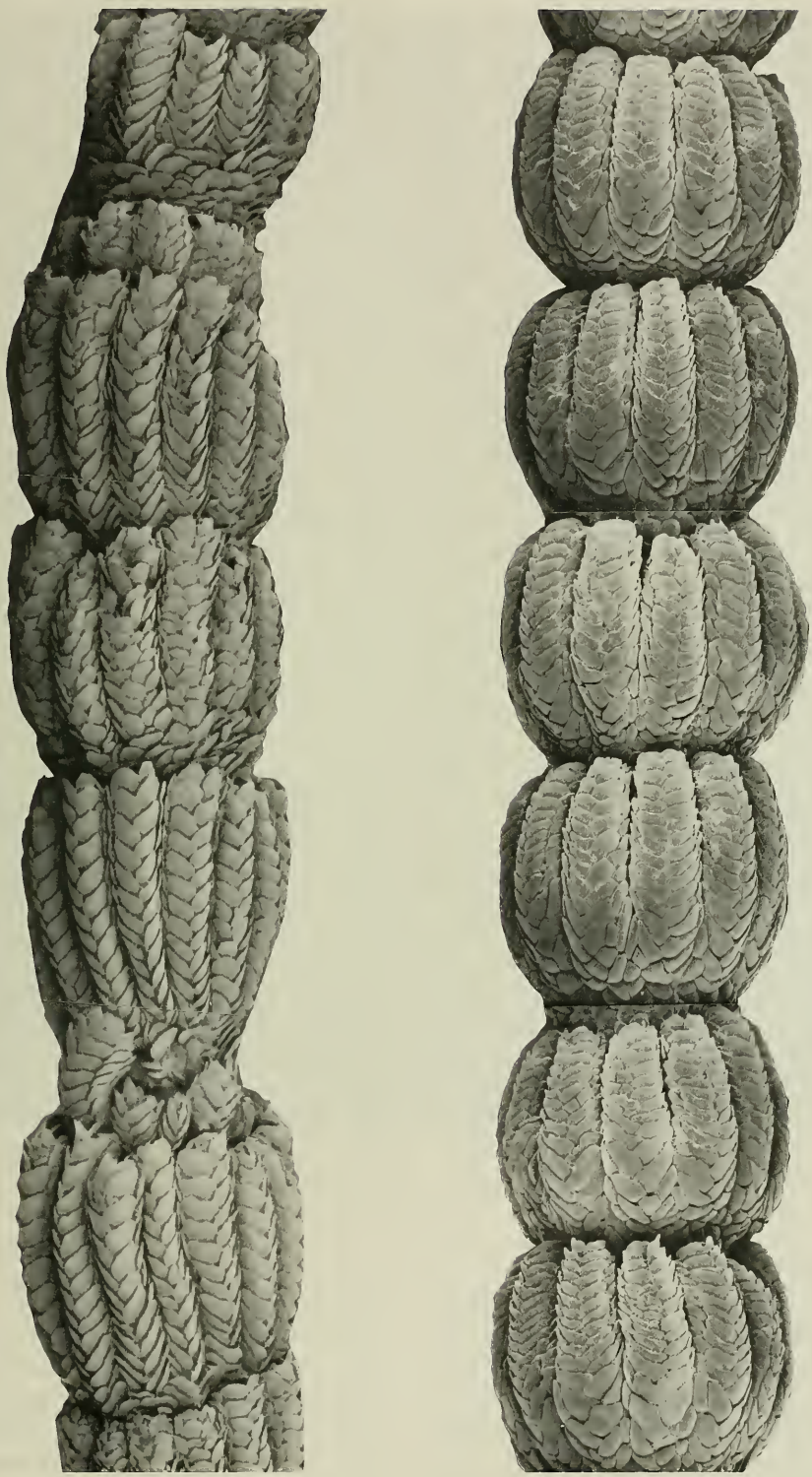


Fig. 19. *Primnoella australasiae* Gray. Left, from D'Entrecasteaux Channel, Tasmania, USNM 58926; Right, from Bluff Harbor, New Zealand, USNM 4505.

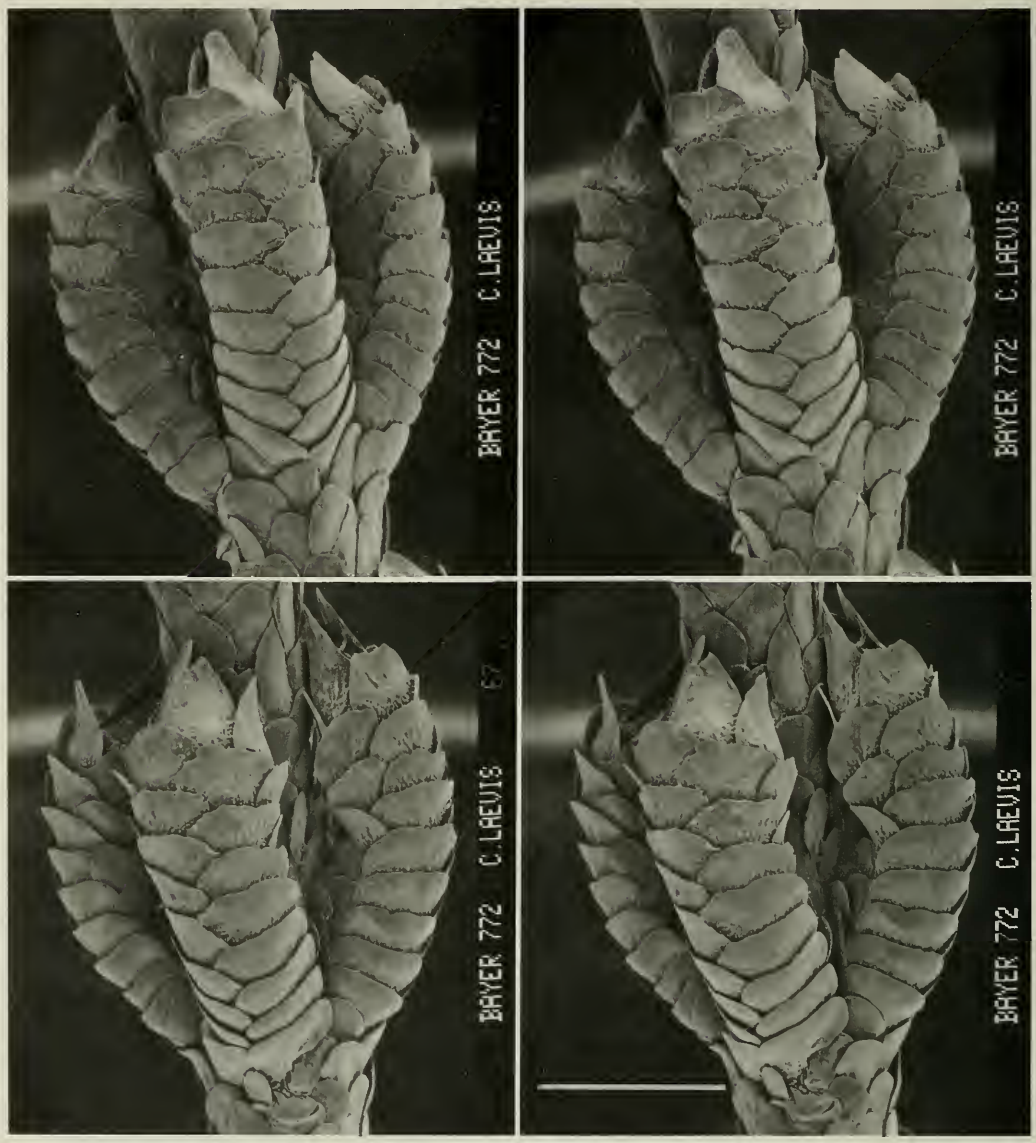


Fig. 20. *Primnoella laevis* (Thomson and Mackinnon), from east of Broken Bay, N.S.W., Australia. Two whorls from syntype, scale bar = 0.5 mm. Stereoscopic pairs (SEM 772).

Studer, 1879; *murrayi* Wright & Studer, 1889; *antarctica* Kükenthal, 1907; *distans* Studer, 1879; *divaricata* (Studer, 1879); and *divergens* Hickson, 1907.

Of these, *Primnoella flagellum* Studer, 1879, is here interpreted as a variant of *P. magelhaenica* Studer, 1879.

Kükenthal (1912:317) described *Primnoella vanhoeffeni* as similar to *P. magellanica* (sic), but his illustrations are not convincing.

Primnoella murrayi Wright & Studer (1889:84, pl. 18, figs. 3, 3a) is similar to *P. magelhaenica* but has a short apical spine or acute angle on the distal margin of the abaxial body scales, a character so variable in *P. magelhaenica* that the species can be considered synonymous.

Kükenthal (1919:387, 391) placed his *Primnoella antarctica* in the "Convexae" group of species because the polyps are not compressed, even though the adaxial side is mostly naked except for a few small scales below the mouth and near the base; it bears some resemblance to *Ophidiogorgia* but none at all to *Convexella magelhaenica.*

The polyps of *Primnoella distans* Studer, 1879, have only two visible rows of large abaxial scales (Wright & Studer 1889, pl. 18, fig. 1a), and very small, reduced adaxial scales, so must be referred to the "Compressae" group of species.

Based upon Studer's type, Versluys (1906:54) described *Primnoella divaricata* (Studer, 1879), as very similar to *P. australasiae* but with the adaxial side of the polyps completely covered by scales smaller than those of the abaxial rows; it conforms better with the "Compressae" group and therefore is here treated as a species of *Primnoella.*

About all that can be said about *Primnoella divergens,* given the inadequate description and figure originally provided (Hickson, 1907:10, pl. 1, figs. 8–10), is that it is not one of the "Compressae" group but may be a species of "Convexae."

As originally described and illustrated, both *Primnoella jungerseni* Madsen, 1944, and *P. krampi* Madsen, 1956, fall within the "Convexae" group of species, hence are here reassigned to *Convexella.* Although Madsen (1944:42) compared *P. jungerseni* with *P. distans* and *P. polita* Deichmann, 1936, in both of those species only two rows of abaxial scales are visible, making both referable to the "Compressae" group, hence *Primnoella* s.s.

Primnoella gracilis Molander, 1929, originally was compared with *P. flagellum* and, as described and illustrated (Molander 1929:63, figs. 17, 18; pl. 1, fig. 2), falls within the "Convexae" group on the basis of its well-developed adaxial scales. However, the marginal scales show no tendency to override the opercularis, as is the case in both *Primnoella* and *Convexella,* so the species probably is excluded from both genera.

Gravier (1914:77) aligned his *Primnoella kuekenthali* with the "Convexae" group (1914:83), but his illustrations and lengthy description throw some doubt upon that assignment. The body scales are thick, sculptured externally by large ridges that may branch, and have strongly dentate margins, whereas the sclerites of *Primnoella* "Convexae" are thin and externally smooth. Gravier's statement that on the concave adaxial surface of the polyps "il y a une bande médiane qui reste à nu" suggests that *kuekenthali* may be referable to *Ophidiogorgia* Bayer, 1980. This conclusion is confirmed by specimens from Marguerite Bay (68°30′S, 68°30′W, USNM 56631), South Shetland Islands (62°17′30″S, 58°34′36″W, USNM 78398; 63°26′S, 62°10′W, USNM 77456; 62°16′42″S, 58°34′00″W, USNM 77361), Livingston Island (63°24′S, 62°14′W, USNM 82863), Anvers Island (64°46′28″S, 63°26′30″W, USNM 81544), Elephant Island (62°39′S, 56°10′W, USNM 82852), Adelaide Island (67°48′12″S, 68°54′06″W, USNM 77460), all from along the Antarctic Peninsula in the general vicinity of the type locality (64°50′S, 63°30′W), as well as from the South Orkney Islands (60°26′30″S, 45°53′18″W, USNM 77145), that agree in all essentials with Gravier's description of *Primnoella kuekenthali.* As in his material, the interval between whorls and the size of polyps within whorls is subject to considerable variation; in two specimens (USNM 56631, 77456), new whorls are intercalated between fully developed whorls just as illustrated by Gravier (1914:82, fig. 108). Gravier's drawing shows the body scales aligned longitudinally, unlike the case in *Ophidiogorgia paradoxa* Bayer but, in the specimens now available, this regular arrangement is disrupted in almost all fully developed polyps. It must be remembered that the then unique type specimen of *O. paradoxa* was deformed by the presence of some epizoan, possibly echinoderm, which may have disrupted the development of sclerites in the polyps of adjacent

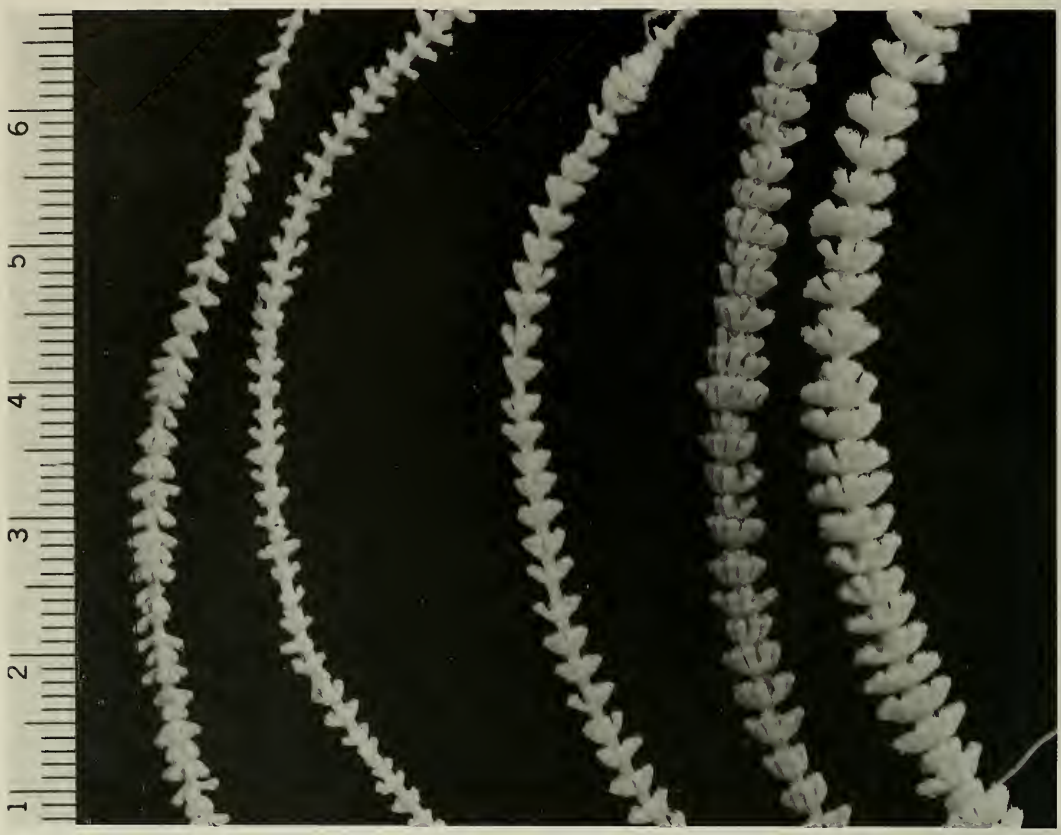


Fig. 21. *Convexella magelhaenica* (Studer), USNM 85300, from north of Cabo San Diego, Tierra del Fuego, 124–119 m, showing variation present among specimens from a single haul. See Figs. 27, 28.

whorls. Although Gravier described the distalmost scales of the polyps as an operculum, his drawing (1914:81, fig. 105) of one opercular scale is no more clearly differentiated from the body scales than are those of *O. paradoxa.* Accordingly, *Primnoella kuekenthali* Gravier, 1913, is here transferred to *Ophidiogorgia* as *O. kuekenthali,* new combination, pending detailed studies to clarify its relationship with *O. paradoxa.*

Distribution.—Except for *Convexella jungerseni* (Madsen), all species of *Convexella* are confined to the southern hemisphere.

Specimens from Balleny Islands (66°53′S, 163°19′E, USNM 77330) and the vicinity of Wilkes Station (66°15′24″S, 110°28′40″W, USNM 88775) clearly referable to *Ophidiogorgia* indicate that the genus and probably the species are of circum-Antarctic distribution.

Convexella magelhaenica (Studer, 1879), new combination
Figs. 21–38

Primnoella magelhaenica Studer, 1879:644, pl. 2, fig. 10a–c.—Kükenthal, 1919:389, pl. 40, figs. 50, 51; 1924:281 (references).—Broch, 1965:21, pl. 1, fig. 1.

Primnoella magellanica Wright & Studer, 1889:83, pl. 17, fig. 2; pl. 21, fig. 10. (incorrect subsequent spelling).—Thomson & Ritchie, 1906:855, pl. 1, fig. 3 (incorrect subsequent spelling).—Versluys, 1906:51 (unjustified emendation).

Primnoella flagellum Studer, 1879:645, pl. 2, fig. 11a–c.—Wright & Studer, 1889:

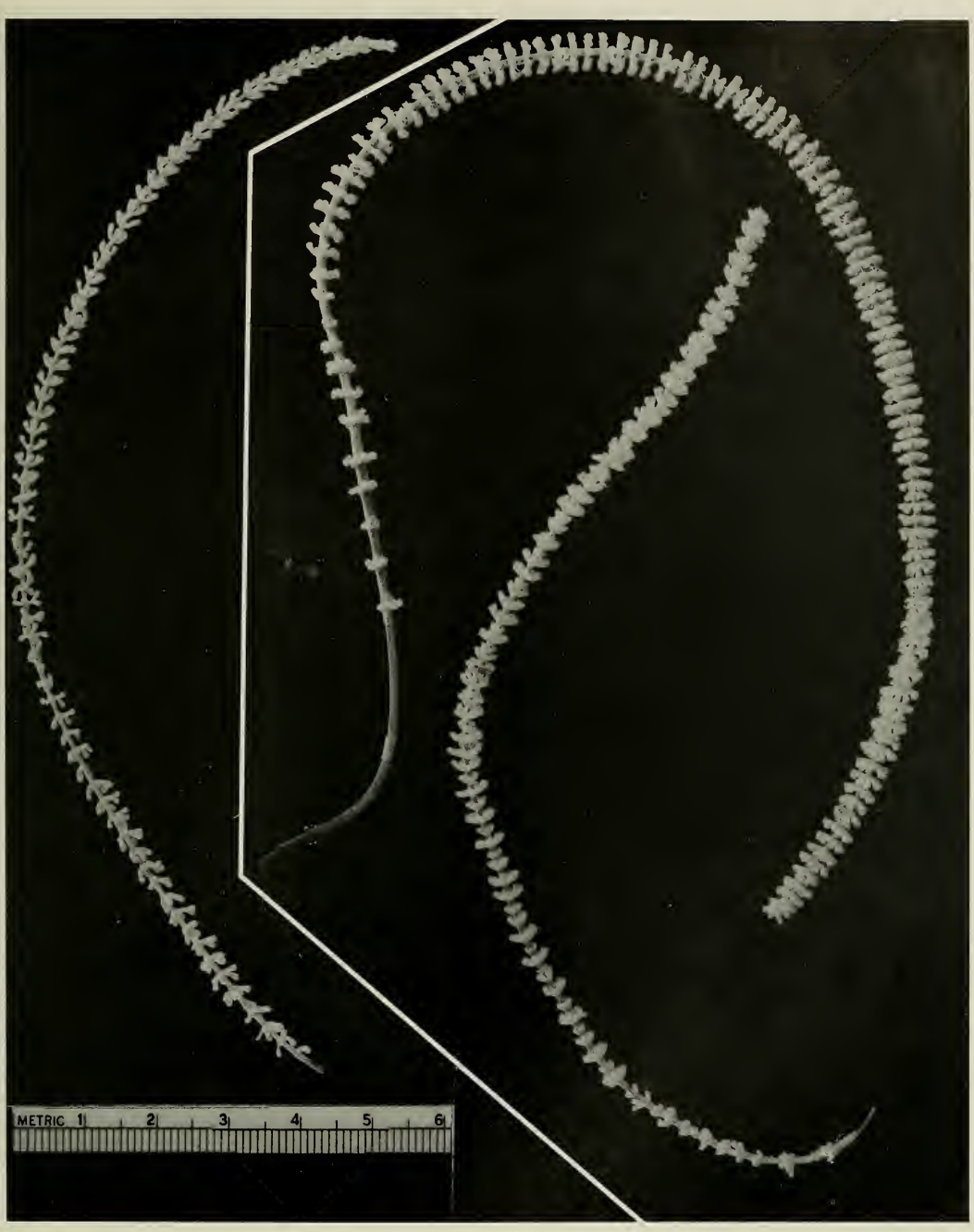


Fig. 22. *Convexella magelhaenica* (Studer). Left, Colony from off Isla Desolacion, Magellanes, Chile, 1500–1666 m, showing polyps directed distad on distal part, basad on basal part, USNM 82856 (see Fig. 35 for detail of polyps); Right, Two colonies from off Cabo San Sebastian, Tierra del Fuego, 86 m, USNM 85306, showing polyps standing vertically as in *Callozostron* (compare figs. 1, right, and 7, top; see Figs. 23, 24 for detail of whorls and polyps).

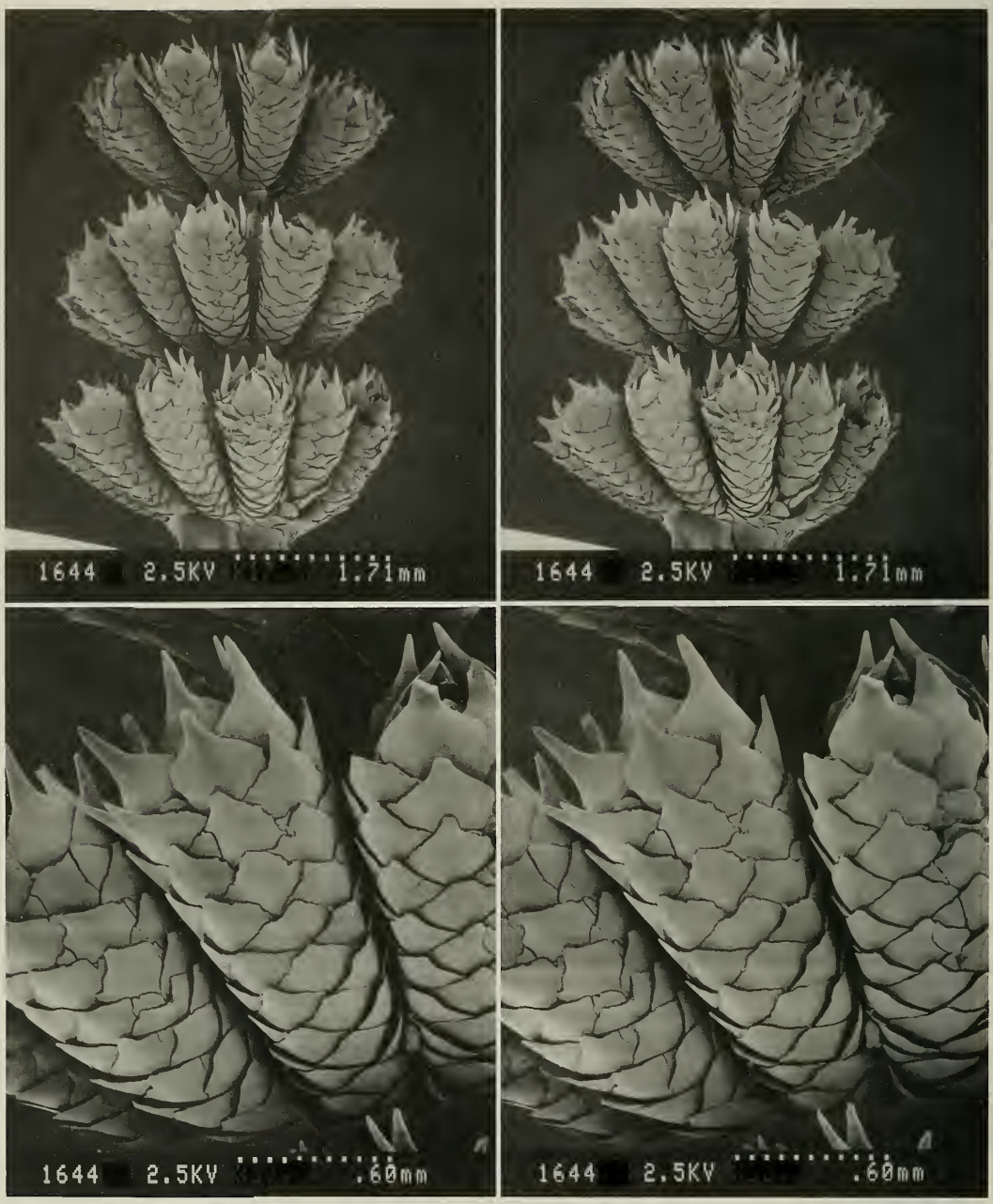


Fig. 23. *Convexella magelhaenica* (Studer), USNM 85306, from off Cabo San Sebastian, Tierra del Fuego, 86 m. Top, Three whorls; Bottom, Detail of polyps showing development of apical spines on distal body scales. Stereoscopic pairs (SEM 1644).

85, pl. 18, figs. 2, 2a; pl. 21, fig. 12.—Versluys, 1906:51.

?*Primnoella flagellum*.—Thomson & Mackinnon, 1911:688.

Material examined.—35 lots. See appendix.

Discussion.—Studer's (1879) original description and illustrations of *P. magel-*

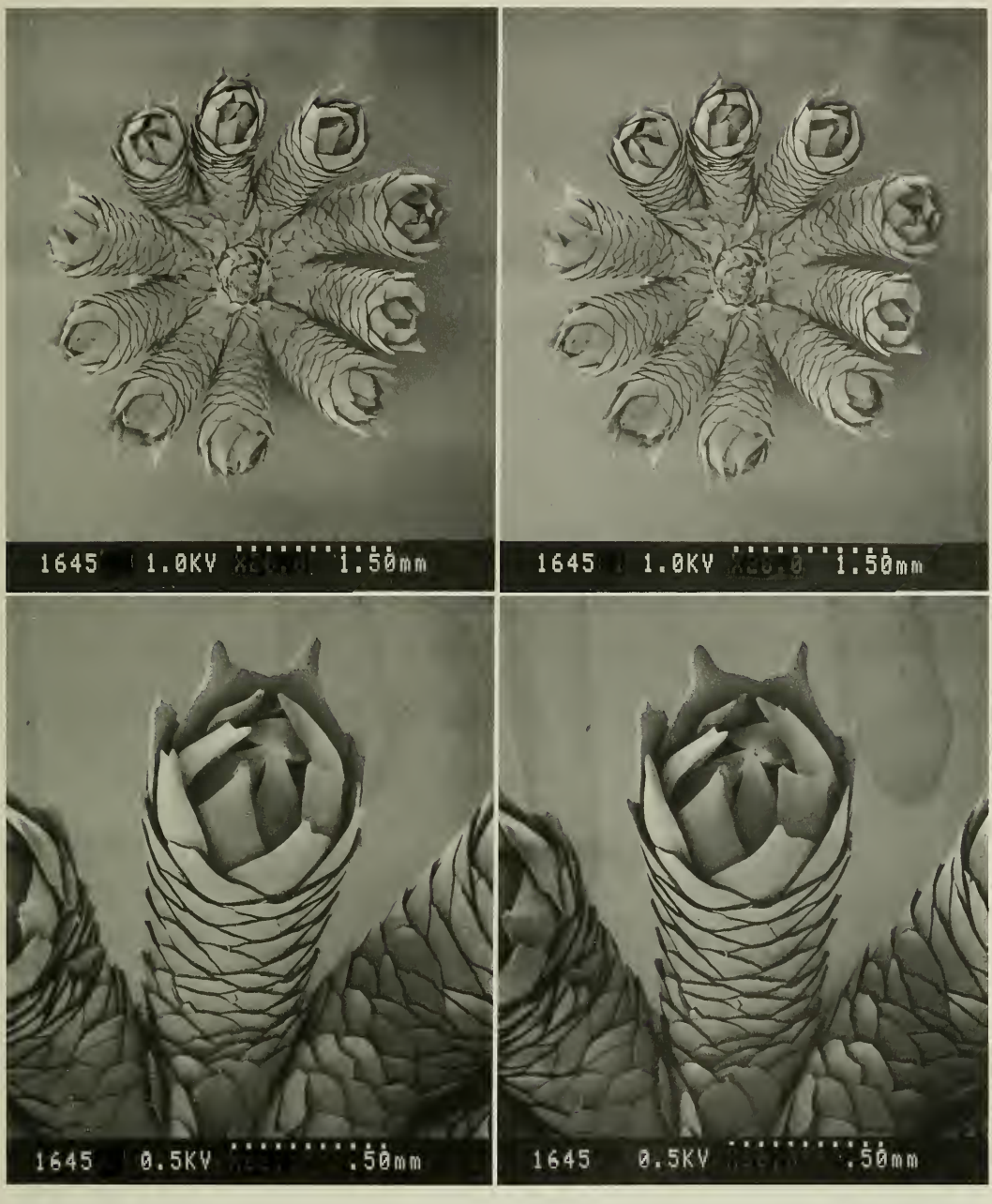


Fig. 24. *Convexella magelhaenica* (Studer), USNM 85306, from off Cabo San Sebastian, Tierra del Fuego, 86 m. Top, Whorl of polyps seen from above; Bottom, Oblique view of polyp showing circumoperculum. Stereoscopic pairs (SEM 1645).

haenica, collected at a depth of 42 fathoms (= 77 m) in the Straits of Magellan by the *Gazelle,* are not adequate to distinguish the species from others described subsequently. Wright & Studer (1889), Thomson & Ritchie (1906), Kükenthal (1919), and Broch (1965) have described and illustrated specimens purported to be *magelhaenica,* but in

Fig. 25. *Convexella magelhaenica* (Studer), USNM 89344, from between Tierra del Fuego and Falkland Islands, 128 m. Top, Part of slender colony with whorl of new polyps between fully developed whorls (SEM 1934); Bottom, Part of stouter colony showing new polyp between fully developed individuals within a whorl, as well as new whorl almost hidden by fully developed whorl (SEM 1931). Stereoscopic pairs.

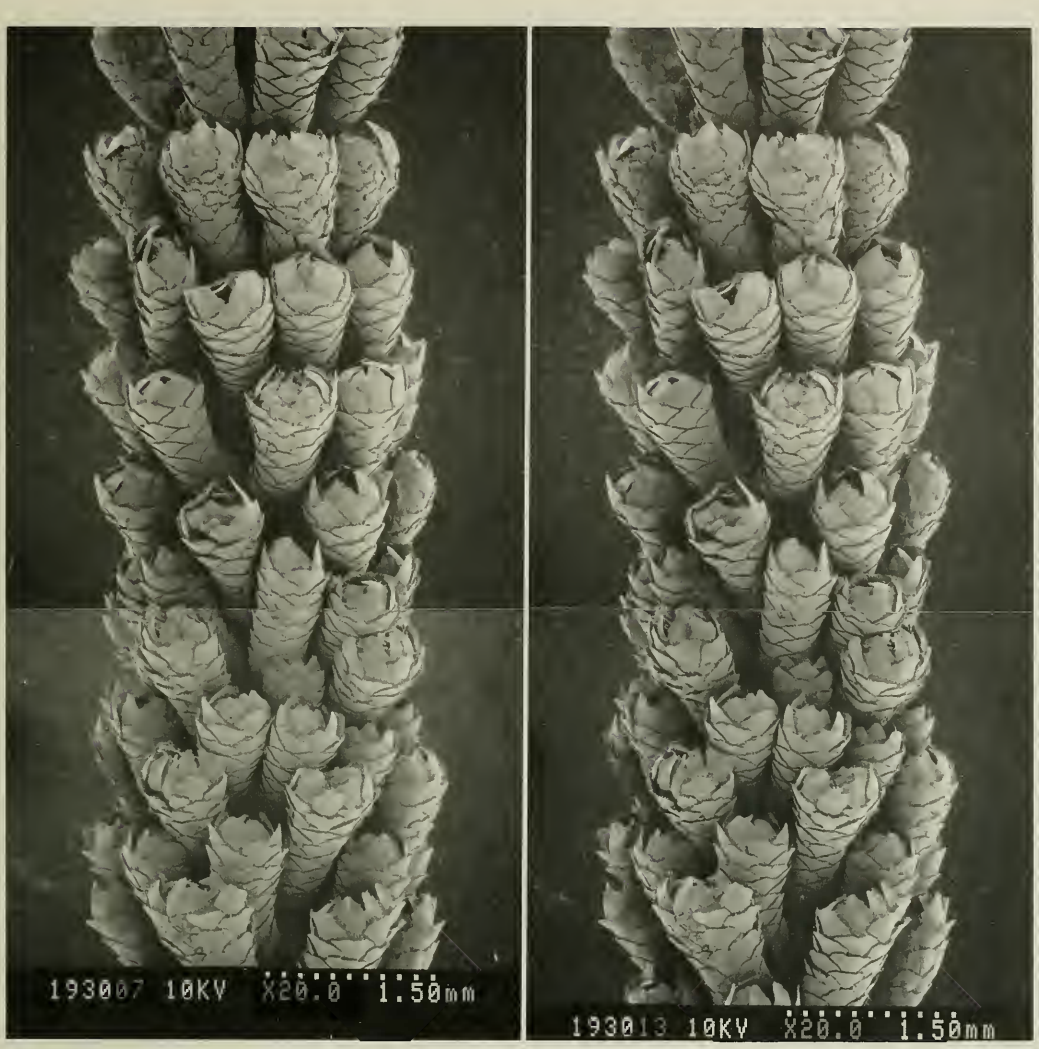


Fig. 26. *Convexella magelhaenica* (Studer), USNM 89344, from between Tierra del Fuego and Falkland Islands, 128 m. Part of stout colony with polyps exceptionally crowded. Stereoscopic pairs (SEM 1930).

no case was identification confirmed by comparison with the type specimen. It is reasonably certain that the specimens in the present collection are conspecific with Thomson & Ritchie's, Kükenthal's, and Broch's material. Wright & Studer's descriptions and illustrations of both *P. magellanica* (incorrect subsequent spelling of *magelhaenica*) and *P. flagellum* are consistent with the numerous specimens now on hand from the same general geographical area. It should be remembered, however, that if future study should prove Wright & Studer's specimen of "*magellanica*" to represent a species different from *P. magelhaenica,* it may take the available name *magellanica* dating from Versluys, 1906.

The present material, consisting of specimens of a wide range in size, from young colonies 2.5 cm tall with 7 whorls of polyps in 2's and 3's, to mature specimens more than 40 cm tall, with 7 whorls of 15 polyps each in 1 cm, comprises colonies agreeing with the characters heretofore described for *P. magelhaenica, P. flagellum,* and *P.* "*magellanica.*" Colonies of intermediate size

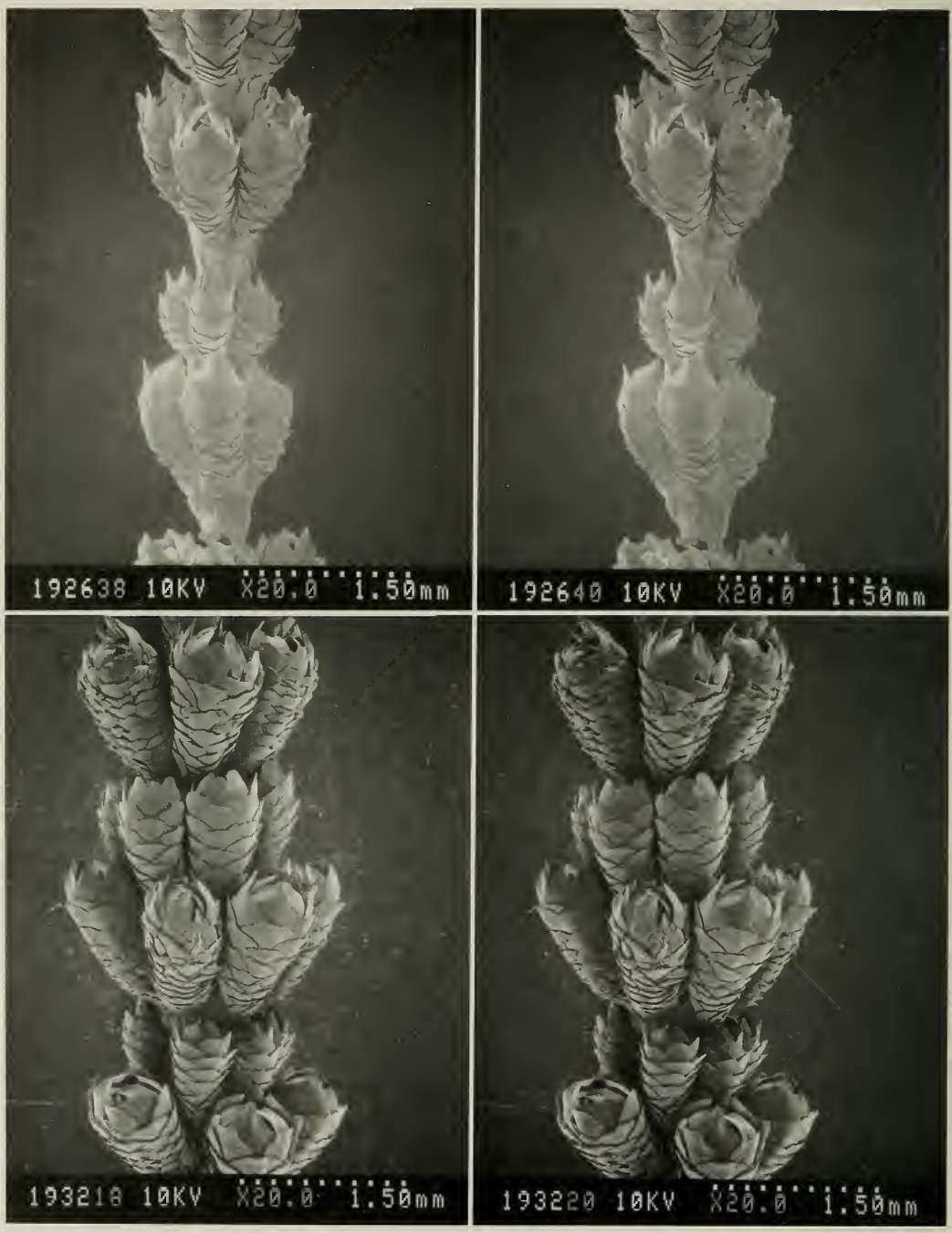


Fig. 27. *Convexella magelhaenica* (Studer). Top, USNM 85300, from north of Cabo San Diego, Tierra del Fuego, 124–119 m; part of slender colony with whorl of new polyps between two fully developed whorls (SEM 1926). Bottom, USNM 89344, from between Tierra del Fuego and Falkland Islands, 128 m; part of stouter colony with crowded whorls of different ages (SEM 1932). Stereoscopic pairs.

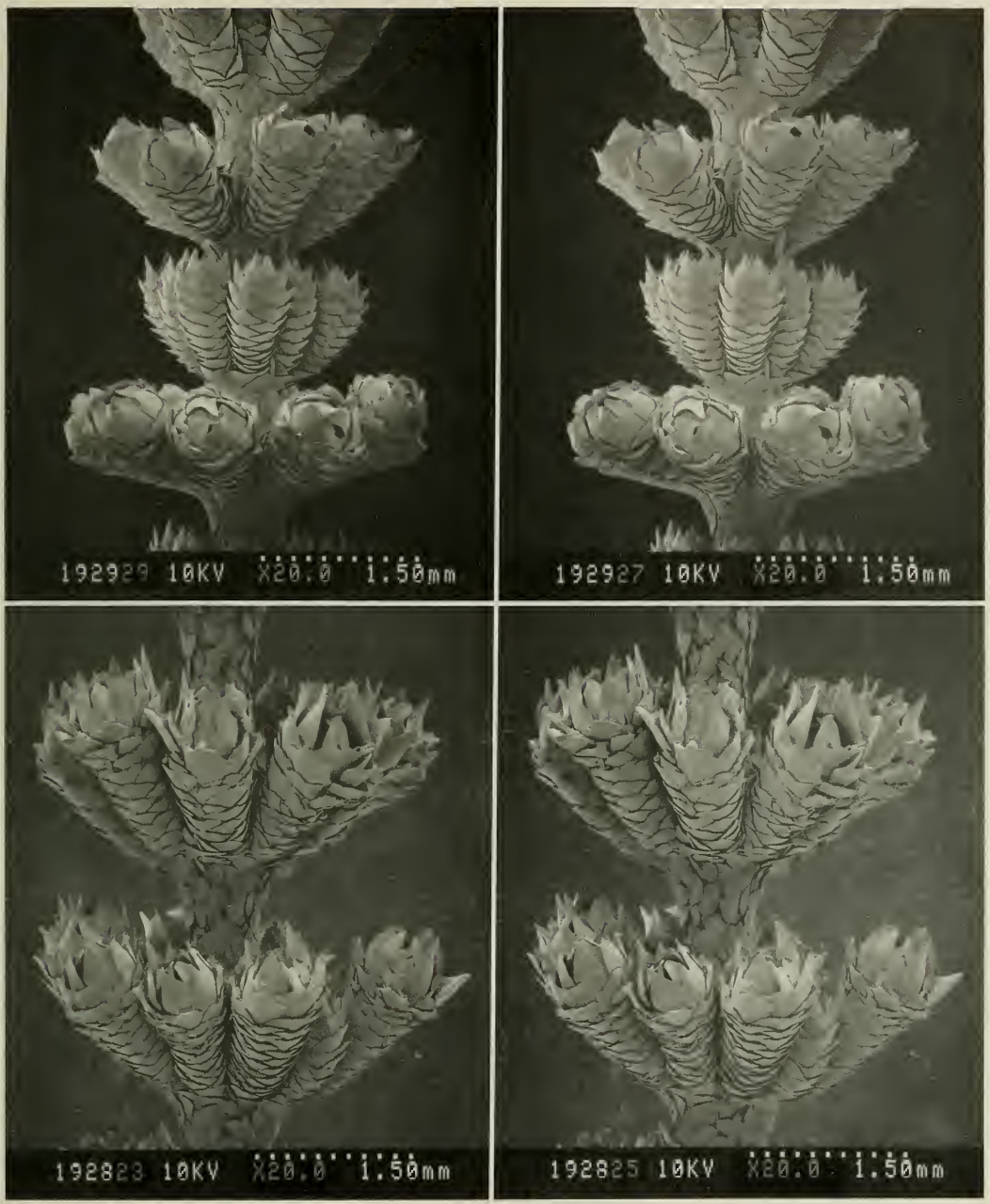


Fig. 28. *Convexella magelhaenica* (Studer), USNM 85300, from north of Cabo San Diego, Tierra del Fuego, 124–119 m. Top, Part of stout colony with whorl of upturned new polyps between two fully developed whorls of outwardly directed polyps (SEM 1929); Bottom, Part of stouter colony having polyps with exceptionally strong circumopercular spines (SEM 1928). Stereoscopic pairs.

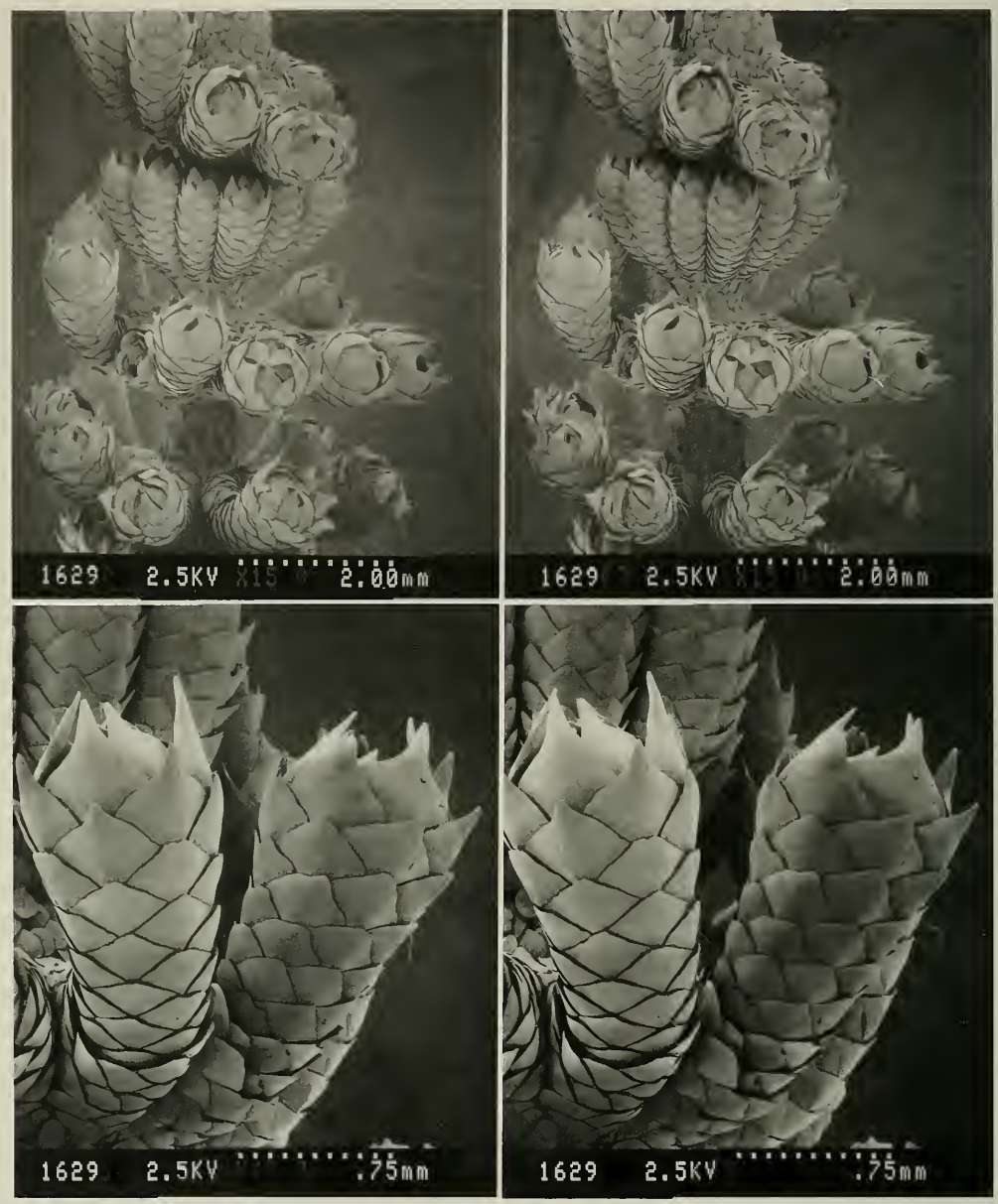


Fig. 29. *Convexella magelhaenica* (Studer), USNM 58441, from Strait of Le Maire, 229–265 m. Top, Part of branch showing young whorl with polyps turned strongly upward, situated between fully developed whorls with some polyps projecting almost vertically from axis; Bottom; Detail of two polyps. Stereoscopic pairs (SEM 1629).

may have from 3 to 7 whorls in 1 cm of axial length, varying from 3 to 8 or more polyps per whorl, the distalmost sometimes only 2.

Broch (1965:21) did not provide a formal decription of his specimens of *P. magelhaenica* from Burdwood Bank but commented that his "rather copious collection exhibits a comparatively broad variation" from "slender specimens" to "more coarse

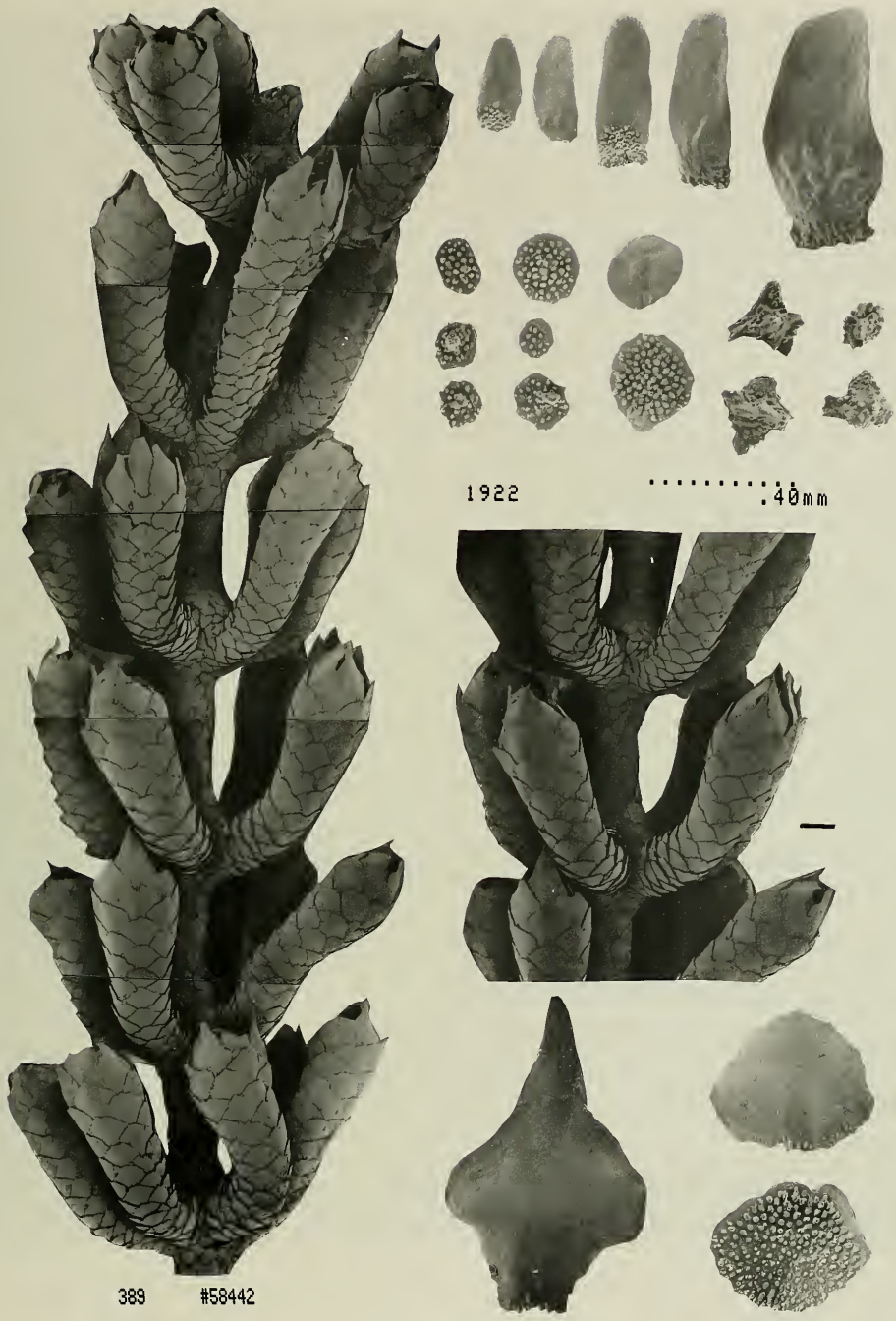


Fig. 30. *Convexella magelhaenica* (Studer), USNM 58442, from east of Cape Horn, 384–394 m. Part of stem with polyps bent upward but not appressed to stem; middle portion in stereoscopic view, scale bar = 1 mm (SEM 389). Isolated sclerites (SEM 1922): top row, operculars; second row, outer (left group) and inner (right group) coenenchymals; bottom row, circumopercular and body scales.

Fig. 31. *Convexella magelhaenica* (Studer), USNM 85288, from Sars Seamount in Drake Passage, 512–622 m. Top, Part of branch with whorls of polyps; Bottom, Polyp in side view, showing negligible development of marginal points on distal body scales. Stereoscopic pairs (SEM 1647).

colonies." His specimens were 12–18 cm long, a size not unusual in the material reported here. However, the longest specimen from *Eltanin* station 217 from off Cabo San Diego, Tierra del Fuego (USNM 78403), is a slender colony 48 cm long. The type specimen of *Primnoella magelhaenica* was 22 cm long, and that of *P. flagellum* 53 cm, so

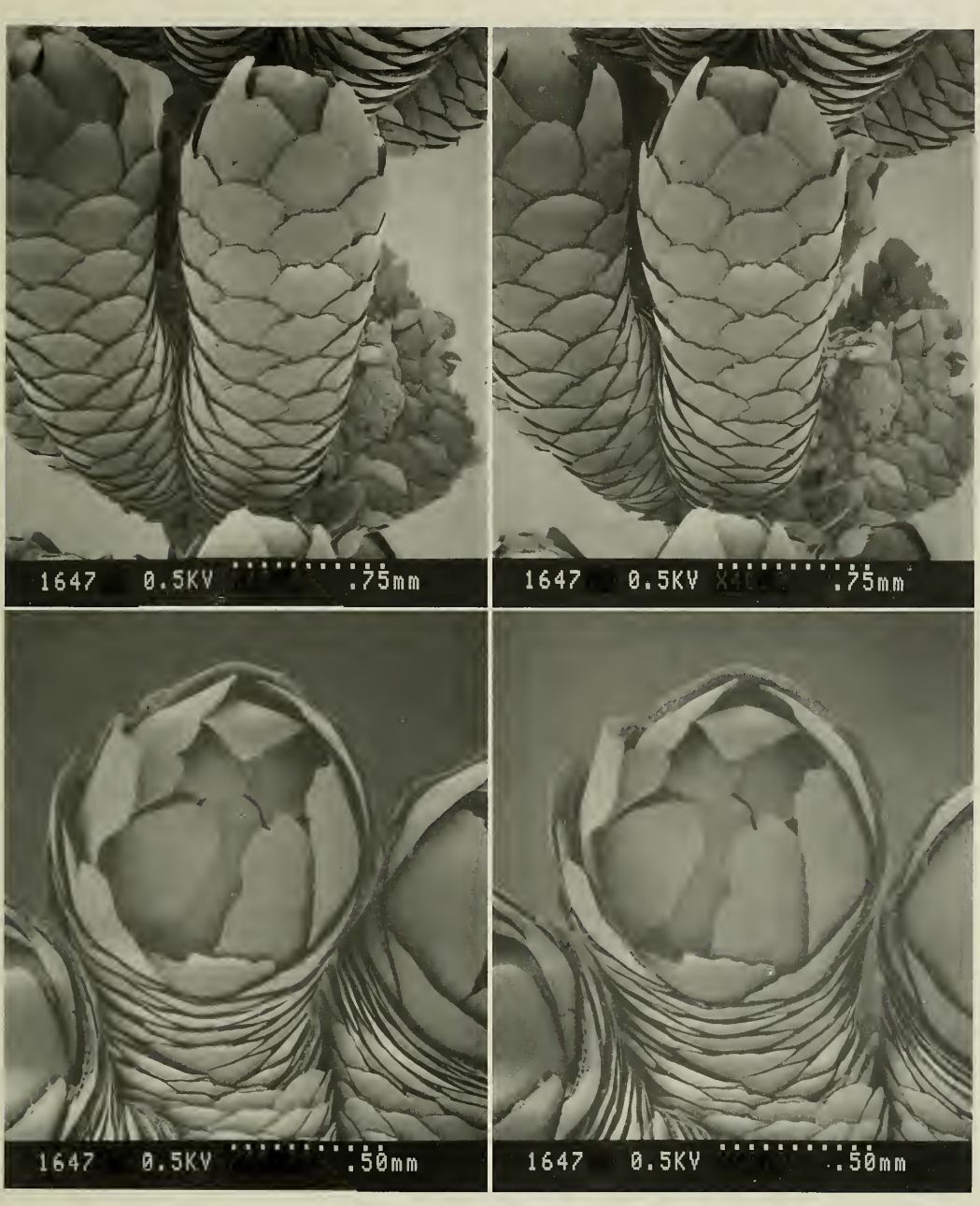


Fig. 32. *Convexella magelhaenica* (Studer), USNM 85288, from Sars Seamount in Drake Passage, 512–622 m. Top, Polyp in abaxial view; Bottom, Oral view of polyp with circumopercular scales closed over operculars. Stereoscopic pairs (SEM 1647).

it is probable that the former is a colony similar to the "more coarse colonies" mentioned Broch and abundantly represented in the present material, whereas *P. flagellum* is like Broch's "slender specimens." Both extremes are present in the lots from *Eltanin* stations 217 (USNM 78403), 369 (USNM 77371), 974 (USNM 85300), and 976 (USNM 89344), all from east of Tierra del Fuego.

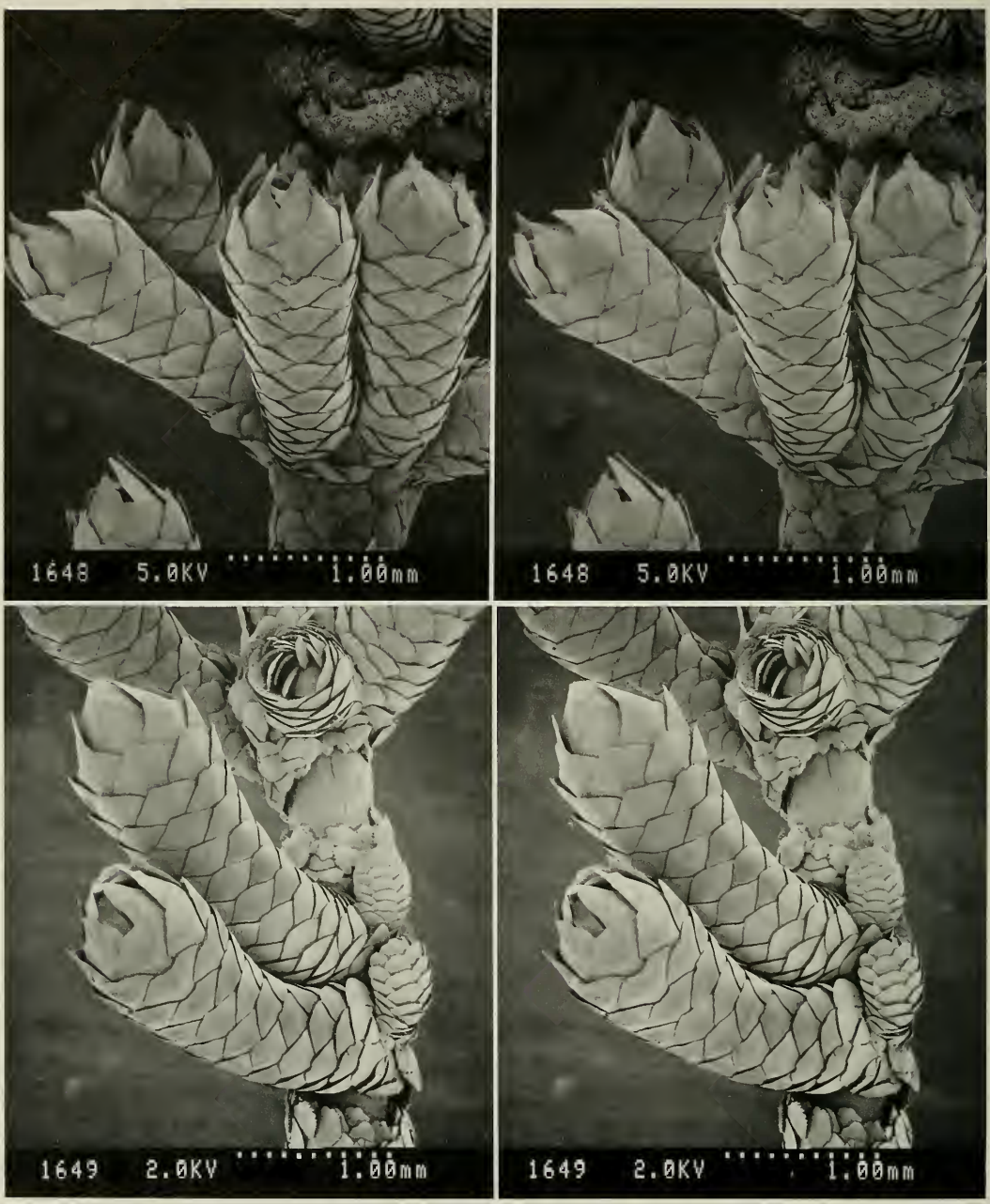


Fig. 33. *Convexella magelhaenica* (Studer), USNM 85298, from Strait of Le Maire, 641–596 m. Top, Detail of whorl showing polyps in abaxial and lateral views (SEM 1648); Bottom, Young polyps developing between adult polyps within two whorls from which some of the adult polyps have been removed. The young polyps have 7 scales in the abaxial rows compared to 13 in the adults, showing that the number of scales can be age dependent (SEM 1649). Stereoscopic pairs.

Broch (1965:20–22) commented on the production of new polyps and new whorls in *Primnoella* and reported some differences in this respect among *P. magelhaenica, P. scotiae,* and *P. vanhoeffeni.* He reported that new whorls arise in the middle and upper parts of the polyparium in *P. magelhaenica.* In the present material, development of new whorls is very variable. In some colonies, few new whorls are intercalated between fully developed whorls but, in others, new whorls may arise throughout the length of the colony, indicating different states of colonial growth at the time of collection. In a specimen from *Eltanin* station 976, two new whorls of different sizes may occur in the space between two fully developed whorls.

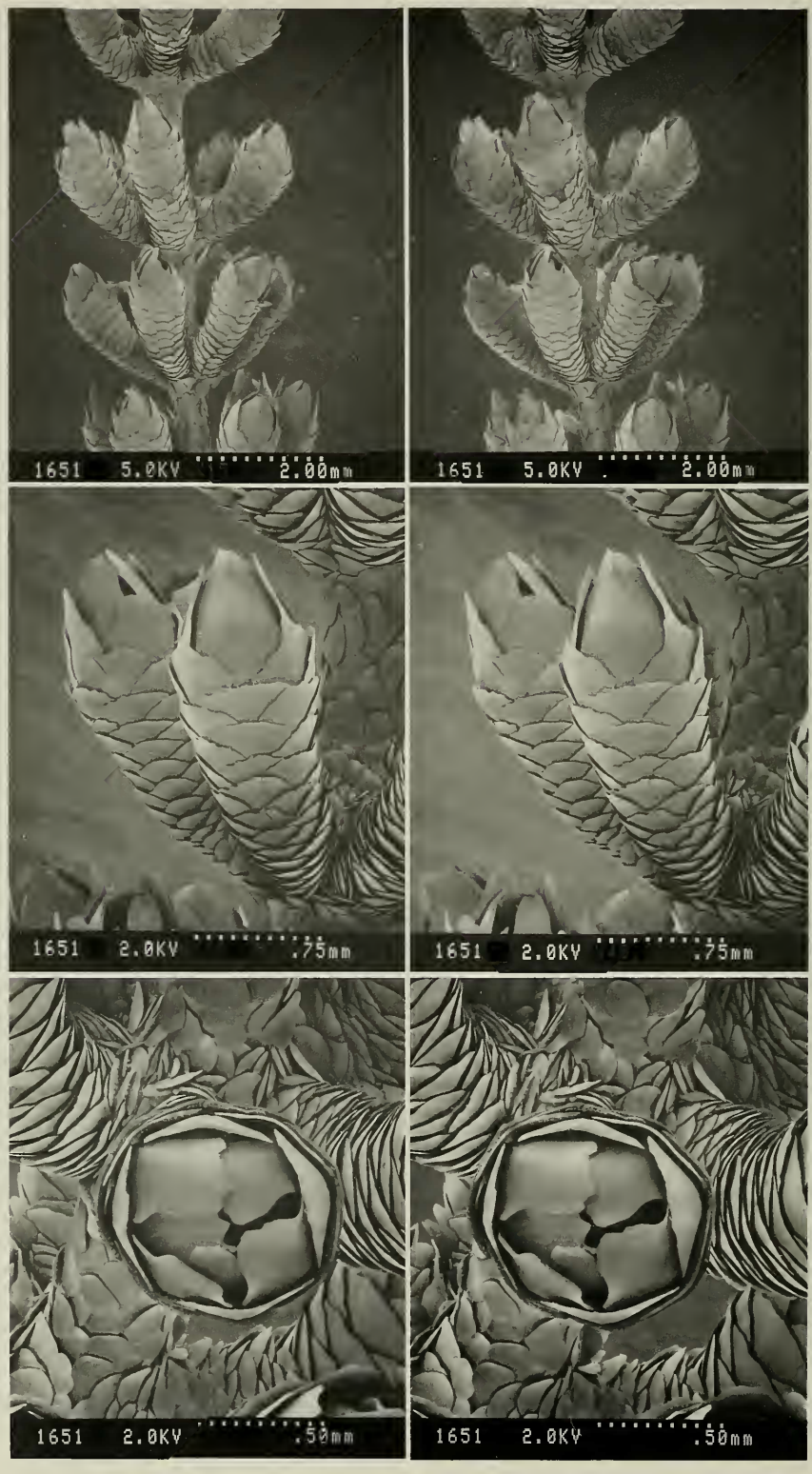
Studer (1879:645) reported that the body scales "stehen in 13–14 Querreihen um die Kelche," and Wright & Studer (1889:83) wrote that "ten to thirteen calyx scales may be counted" in the length of the calyx, but in neither case do the accompanying illustrations suggest so many. Studer (1879:645) said that in *P. flagellum* the body scales "stehen um die Kelche in acht Reihen," a number that occurs in the present material.

Colonies are sometimes attached to a stone or shell by a small, discoidal, calcified holdfast, but the supporting substrate is not often collected with the specimens. Most are broken off just above the holdfast, part of which may be present, suggesting that the usual substrate is rocky. However, the numerous slender colonies obtained at *Eltanin* station 976 show no sign of attachment. Although all specimens are more or less broken and the axis of most is partially decorticated, in no case can a growing tip at both ends be confirmed. Pogonophoran tubes among the gorgonian stems suggest that the bottom was muddy at this location, making it plausible to conclude that the very flexible colonies lie prone on the substrate in life, as is the case with some species of *Leptogorgia* (Bayer 1961:218–222, Grasshoff 1988:116).

The straight or slightly curved polyps vary in their stance from almost perpendicular to the axis, to directed strongly upward. In no case are they strongly bent inward with the operculum facing the axis. A specimen without holdfast (USNM 82856, Fig. 21, left) has the polyps along the distal half of the colony directed toward the apex, those along the proximal half toward the base. In any given colony, the number of body scales in the abaxial rows may vary from 7 or 8 in polyps near the middle of the colony, to as few as 5 in the polyps of the distalmost and basalmost few whorls; in colonies with the tallest polyps, the abaxial rows commonly consist of 10–11 scales below the circumoperculars, but as many as 14 is unusual. Young polyps have fewer abaxial scales than do fully developed individuals (Figs. 25, 27, 33).

Close observation of isolated polyps during maceration with Sodium hypochlorite shows that the scales of the distalmost circle of 8 body sclerites forming the circumoperculum are not distinctly differentiated functionally from the following 2 or 3 circles, all of which participate in protecting the mouth and withdrawn tentacles during contraction. The distalmost narrow, tongue-shaped sclerites (Fig. 30) that comprise the theoretical "operculum" can fold nearly flat over the mouth in contraction. These are not consistently 8 in number but vary from 6 to 9 or even 10 among polyps of the same whorl. In some cases these differ in size among themselves only slightly and are distinctly smaller than the circumopercular scales; in others the adaxials are very small and the abaxials are as large as, and indistinguishable from, the circumopercular. These and intermediate conditions exist not only in a single colony, but even among the polyps of one whorl.

The arrangement of opercular and circumopercular sclerites resembles that described for *Thouarella hilgendorfi* by Kinoshita (1908:5, fig. 1). In both *Thouarella* and *Primnoella,* sclerites are so large that eight scales cannot fit around the circumference of the polyp in a single circle. In-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1651 2.0KV .50mm

stead, each circle of eight scales surrounding the body is composed of two "transverse rows" of four scales that alternate with one another (Kinoshita 1908), so the "operculum" consists of transverse rows I and II, and the circumoperculum of rows III and IV. The scales seem to be arranged in spirals around the polyp as well as longitudinally, as is shown in Fig. 23.

The abundant material here reported strongly suggests that Studer's *Primnoella magelhaenica* and *P. flagellum* represent a single species, and that Wright & Studer's Kükenthal's, and Broch's records of "*magellanica*" and *magelhaenica* are the same thing. The present material comes from the remarkable bathymetric range from 75 to more than 1500 m. The general aspect of some colonies from the two bathymetric extremes is considerably different and would, in the absence of intermediates, easily be considered specifically distinct. However, morphological variation among specimens from the extremes of bathymetric range differs little from that present among specimens from a single shallow station, making discrimination of two or more species impossible on any objective basis so far detected.

To convey some idea of the similarities and differences among colonies of *P. magelhaenica* over its wide bathymetric range, scanning stereomicrographs have been made of a selection of specimens from the shallowest to the deepest available records, some of which are here presented to document the morphological diversity of this abundant gorgonian.

The shallowest record in the present collection is 73 m, obtained off the north entrance of the Strait of Lemaire, Tierra del Fuego (USNM 85308). Specimens from 86 m off Cabo San Sebastian (USNM 85306) are typical of shallow-water colonies (Figs. 23, 24). The polyps are directed obliquely upward but the whorls do not overlap in the contracted condition; scales of the three distalmost rings of body sclerites have a distinct, smooth apical spine, and the theoretical operculum is concealed during contraction by the uppermost rings of circumopercular scales.

Colonies trawled from 128 m between Tierra de Fuego and the Falkland Islands (USNM 89344) reveal a range of growth-form from slender, with well separated whorls of few polyps (Fig. 25, top) to unusually stout, with crowded, overlapping whorls of eight or more polyps (Fig. 26). Small, evidently young polyps may occur between fully developed individuals within a whorl (Fig. 25, bottom).

A haul made north of Cabo San Diego, Tierra del Fuego in 124–119 m yielded several colonies of diverse aspect (USNM 85300), from slender (Fig. 27, top) to rather stout (Fig. 28). New whorls are intercalated between fully developed ones (Figs. 27, top; 28, top), and the younger individuals may be more strongly inclined toward the axis than are the older (Fig. 28, top), which may stand almost vertically. In one colony the circumopercular scales are so strongly developed that it approaches *Callozostron* in appearance (Fig. 28, bottom).

Colonies from the Strait of Le Maire in 229–265 m (USNM 58441) demonstrate the insertion of new whorls of polyps between fully developed whorls of almost perpendicularly placed individuals (Fig. 29).

A colony from east of Cape Horn in 384–494 m (USNM 58442) has the tallest polyps observed in the present material (Fig.

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Fig. 34. *Convexella magelhaenica* (Studer), USNM 82865, from south of Isla de los Estados, Tierra del Fuego, 771–903 m. Top, Part of branch showing two whorls of polyps with points scarcely developed on distal body scales; Middle, Oblique view of polyps showing scant development of marginal points on body scales; Bottom, Oral view of polyp with circumopercular scales in closed position. Stereoscopic pairs (SEM 1651).

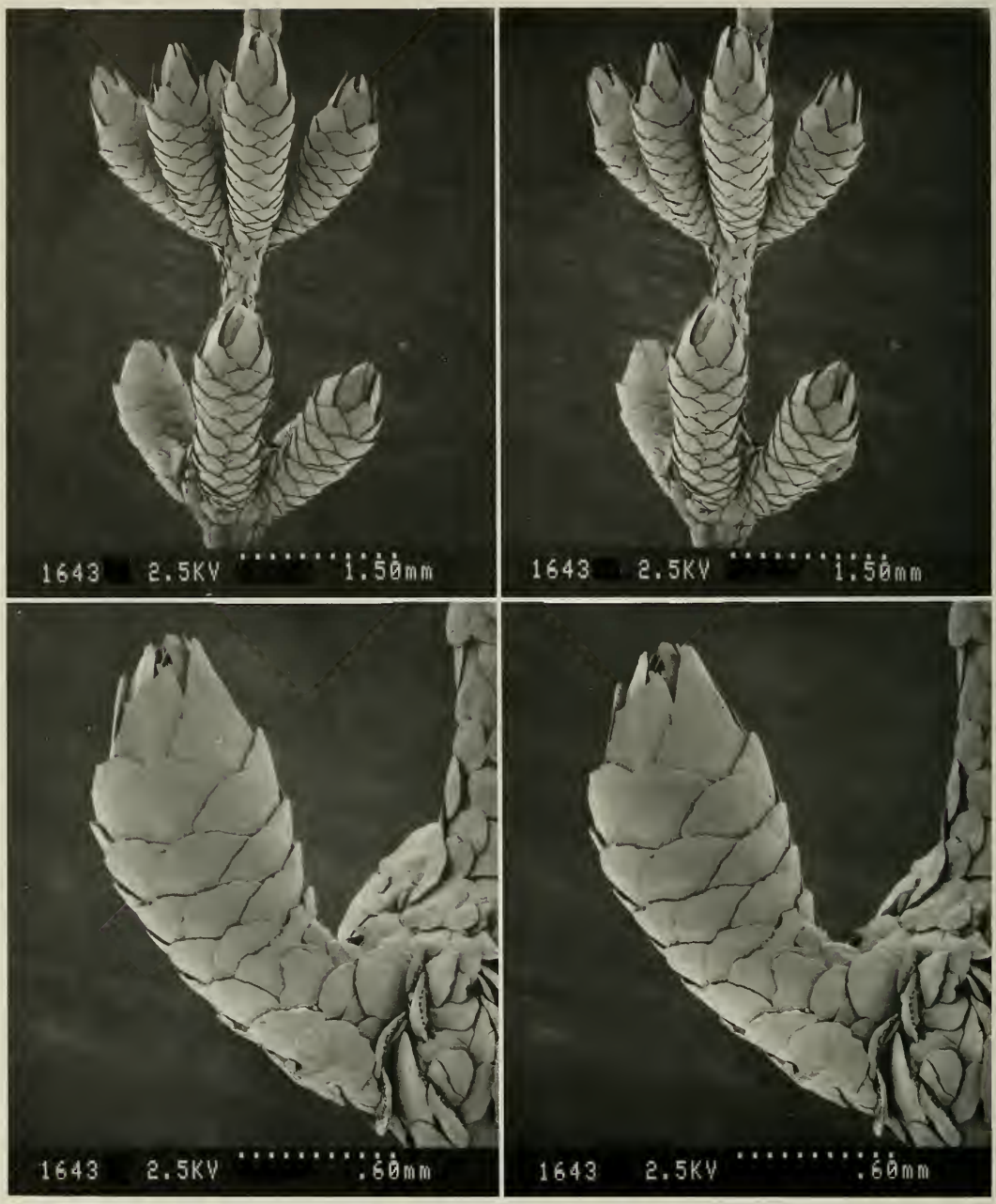

Fig. 35. *Convexella magelhaenica* (Studer), USNM 82856, from off Isla Desolacion, Magellanes, Chile, 1500–1666 m. Top, Part of stem with two whorls; Bottom, Polyp in side view, showing alternating tall and wide circumopercular scales and weak development of apical points. Stereoscopic pairs (SEM 1643).

30). They have 12–13 scales in the abaxial rows, and only the scales of the distalmost transverse row have a strong apical point.

The polyps of a colony from Sars Seamount in Drake Passage trawled in 512–622 m (USNM 85288) are strongly inclined upward and have as many as 13 or 14 scales in the abaxial rows; the the circumopercular

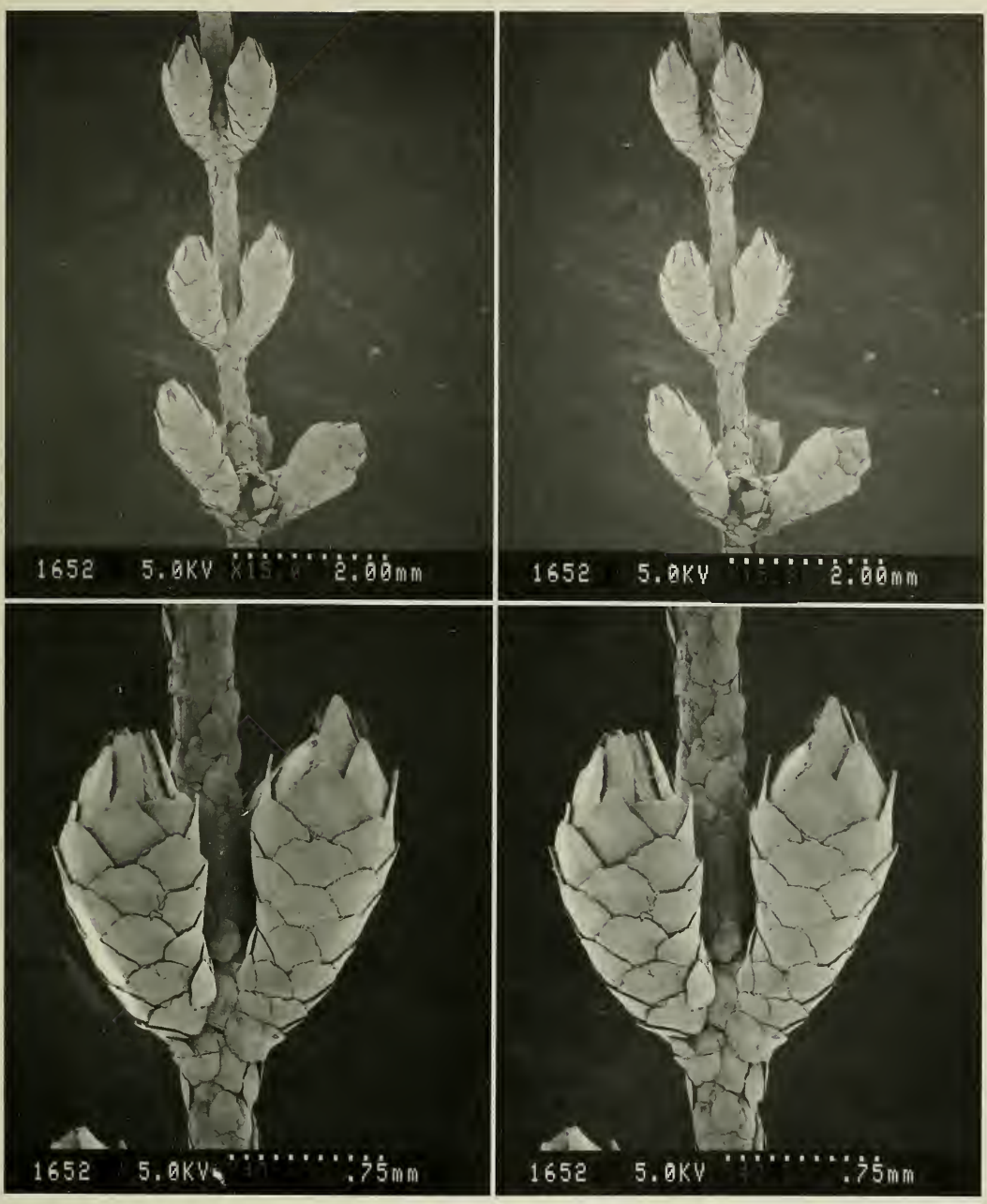

Fig. 36. *Convexella magelhaenica* (Studer), USNM 85302, from east edge of Burdwood Bank, 1647–2044 m. Top, Part of stem with three whorls; Bottom, Detail of polyps. Stereoscopic pairs (SEM 1652).

scales completely obscure the opercularis, and have only a low, rather blunt apex (Figs. 31, 32).

A colony from 641–586 m in the Strait of Le Maire (USNM 85298) has polyps with 10–11 scales in the abaxial rows and circumopercular scales with weakly developed apical angle (Fig. 33). Young polyps developing between fully developed individuals have fewer abaxial scales, showing

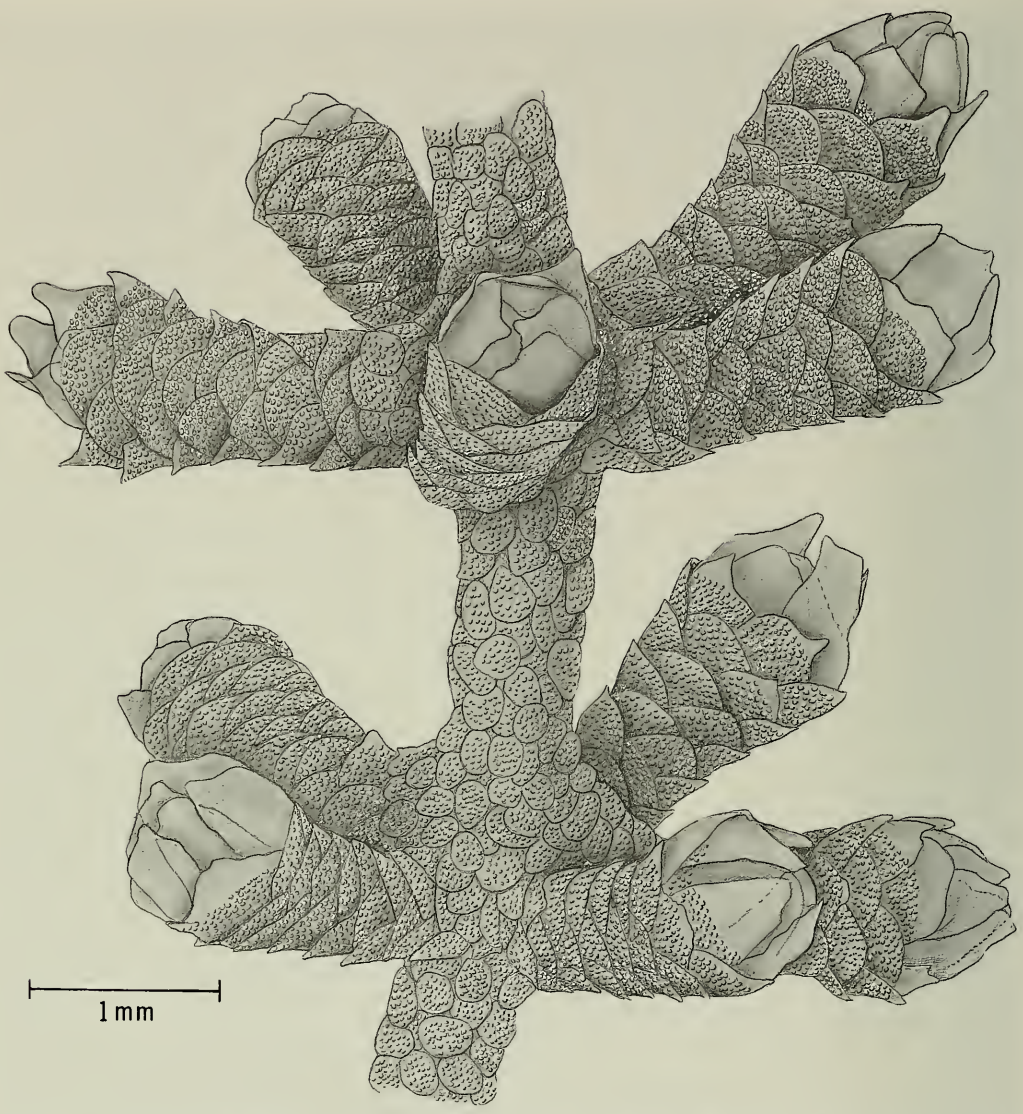

Fig. 37. *Convexella magelhaenica* Studer, USNM 59102, from east of Cape Horn, 384–494 m. Two whorls; camera lucida drawing by Constance Stolen McSweeny from alcoholic specimen, for contrast with SEM images. The tubercles on the inner surface of the scales are clearly visible through the glassy clear sclerites, which are opaque and externally smooth as depicted by SEM.

that the number of scales in the longitudinal rows increases with age.

In colonies from depths of 771–903 m south of Isla de los Estados, Tierra del Fuego (USNM 82865), the uppermost four scales of the circumoperculum are tall and triangular, alternating with the lower four scales which are broader and have a low apical point (Fig. 34).

Colonies from west of Isla Desolacion, Chile, in 1500–1666 m (USNM 82856) are slender, with well spaced whorls of 5 or 6 upwardly directed polyps (Fig. 35). Four tall, triangular circumopercular scales alternate with four broader scales with a low apical angle.

The tendency to be slender and more delicate continues in colonies from 1647–2044

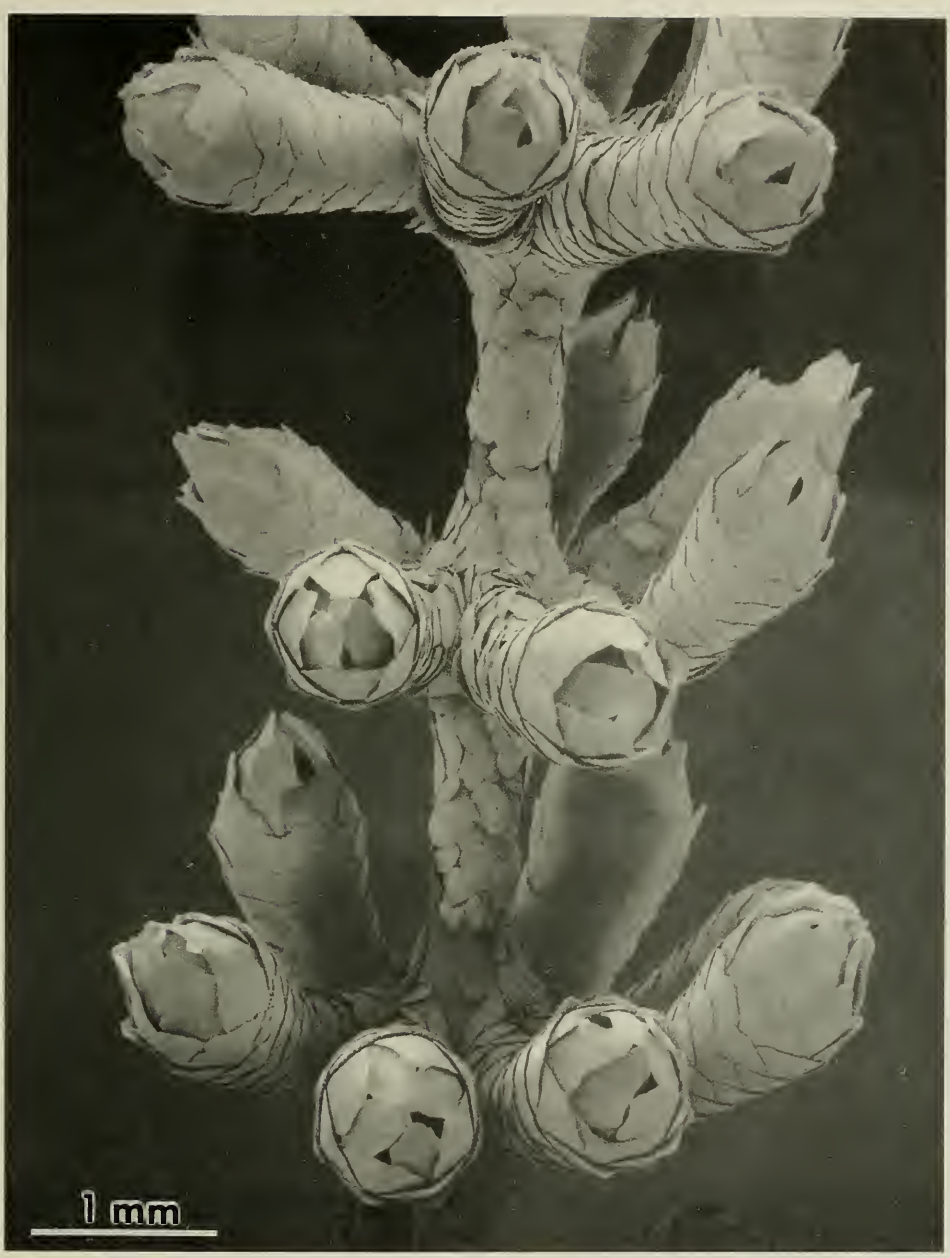

Fig. 38. *Convexella magelhaenica* (Studer), USNM 59102, from east of Cape Horn, 384–494 m. SEM image for comparison with camera lucida drawing in Fig. 36. (SEM 1646.)

m on the eastern edge of Burdwood Bank (USNM 85302), which have well spaced whorls of 3 or 4 upwardly directed polyps (Fig. 35). The four lower circumopercular scales are shorter than the four upper scales, but are more like them than is the case in USNM 82856.

Remarks.—Because heavy reliance upon scanning electron microscopy for highly accurate representation of external morphol-

ogy causes us to lose sight of the fact that primnoid sclerites are more or less translucent, a camera lucida drawing (Fig. 37) of one specimen is given for comparison with SEM representation (Fig. 38). The sclerites of *P. magelhaenica* are translucent, almost glassy clear when wet, so the tubercular sculpture of their inner surfaces is clearly visible with the light microscope but invisible with SEM.

In view of the morphological similarities of *Primnoella magelhaenica* with *Callozostron carlottae* Kükenthal and *C. diplodiademe* new species, it might be as reasonable either to regard *P. magelhaenica* as a weakly spinose *Callozostron,* or *C. carlottae* and *C. diplodiademe* as very spiny species of *Primnoella,* apart from the fact that irregularly tuberculate sclerites are abundantly present in the walls of the longitudinal stem canals in *P. magelhaenica* as they are in *P. australasiae,* but not in species of *Callozostron.*

Distribution.—West and east coasts of the southern extremity of South America, Straits of Magellan and Le Maire, Drake Passage, Tierra del Fuego, eastward to Falkland and South Orkney Islands, 73–1647 m (this collection). Burdwood Bank, 61 fathoms (Broch 1965). This species has not been found in any of its variants anywhere else around the Antarctic continent.

Acknowledgments

Dr. P. F. S. Cornelius of The Natural History Museum (London) made it possible for me to examine Gray's type specimens of *Primnoella australasiae,* and Dr. D. A. Ritz provided specimens recently collected in the type locality by A. J. Blackman. Dr. Pat Hutchings of the Australian Museum (Sydney) provided access to Thomson & Mackinnon's type material of *Caligorgia laevis.* Dr. Manfred Grasshoff of the Naturmuseum Senckenberg (Frankfurt) generously shared his broad knowledge of gorgonacean taxonomy during the preparation of this manuscript and provided many helpful criticisms. The numerous scanning electron micrographs that vastly enhance the value of this paper were made by Mr. Walter R. Brown, head of the SEM Laboratory, National Museum of Natural History. Plates illustrating the sclerites were assembled and mounted by Ms. Molly Ryan, staff illustrator, Department of Invertebrate Zoology, National Museum of Natural History. I here express my sincere thanks to all those who contributed their time and skills toward the preparation of this report.

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Appendix

Convexella magelhaenica (Studer)

Material examined (listed in sequence of USNM catalogue numbers).

58441: Strait of Le Maire: 54°56′S, 65°03′W, 229–265 m, *Eltanin* sta. 969, 10 Feb 1964. Two colonies with holdfast, one attached to bivalve shell. (SEM 1629.)

58442: East of Cape Horn: 56°06′S, 66°19′W, 384–494 m, *Eltanin* sta. 740, 18 Sep 1963. One colony. (SEM 389.)

59102: East of Cape Horn: 56°06′S, 66°19′W, 384–494 m, sta. 740, 18 Sep 1963. Four small colonies originally attached to pebbles and shell, now detached. (SEM 1646.)

59288: East of Cape Horn: 56°06′S, 066°19′W, 384–494 m, *Eltanin* sta. 740, 18 Sep 1963. One colony.

77371: Tierra del Fuego, east northeast of Cabo San Diego: 54°04′S, 63°35′W, 247–293 m, *Eltanin* sta. 369, 12 Dec 1962. 25 colonies, more or less damaged, and 3 denuded axes.

77394: East edge of Burdwood Bank: 54°43′S, 55°30′W, 1647–2044 m, *Eltanin* sta. 1592, 14 Mar 1966. 16 colonies, 8 attached to stones, 5 with part of holdfast, 3 lacking holdfast. (SEM 1652, 1653, 1924.)

78399: Tierra del Fuego, off north entrance to Strait of Le Maire: 54°29′S, 64°00′W, 104 m, R/V *Hero* sta. 863, 22 Oct 1971. Five colonies, one badly damaged.

78403: Tierra del Fuego, east northeast of Cabo San Diego: 54°22′S, 64°42′W, 106–110 m, *Eltanin* sta. 217, 23 Sep 1962. Five colonies lacking holdfast.

78656: Tierra del Fuego, north of Isla de los Estados: 54°50′S, 63°59′W, 0205–0208 m, R/V *Hero* sta. 880, 28 Oct 1971. One colony lacking holdfast.

78657: Tierra del Fuego, north of Isla de los Estados: 54°34′S, 64°40′W, 84–85 m, R/V *Hero* sta. 903, 6 Nov 1971. One colony lacking holdfast.

78661: Chile, west of Isla Desolacion, Magellanes: 52°52′S, 75°18′W, 119–329 m, *Eltanin* sta. 288 Cruise 21*, 6 Dec 1965. Four colonies lacking holdfast, and three fragments.

82847: Between Tierra del Fuego and Falkland Islands: 52°45′S, 66°34′W, 92 m, *Eltanin* sta. 337, 2 Dec 1962. Two damaged colonies.

82856: Chile, west of Isla Desolacion, Magellanes: 53°13′S, 75°41′W, 1500–1666 m, *Eltanin* sta. 283 Cruise 21*, 5 Dec 1965. Three colonies, two somewhat damaged. (SEM 1643, 1923.)

82865: Tierra del Fuego, south of Isla de los Estados: 54°55′S, 64°00′W, 0771–0903 m, R/V *Hero* sta. 875, 27 Oct 1971. Three colonies, smallest with holdfast, and three denuded axes attached to shells. (SEM 1651.)

82866: Tierra del Fuego, off Isla de los Estados: 54°46.9′S, 64°04′W, depth not recorded, R/V *Hero* sta. 881, 29 Oct 1971. Two damaged colonies.

82867: Tierra del Fuego, north of Isla de los Estados: 54°34′S, 64°30′W, 73–75 m, R/V *Hero* sta. 907, 7 Nov 1971. Two incomplete colonies.

85288: Sars Seamount, Drake Passage: 59°49′S, 68°52′W, 512–622 m, *Eltanin* sta. 254, 10 Oct 1962. One colony lacking holdfast, and pieces of denuded axis (SEM 1647).

85290: South of Falkland Islands, vicinity of Beauchene Is.: 53°08′S, 59°23′W, 567–578 m, *Eltanin* sta. 340, 3 Dec 1962. Two colonies, one attached to pebble.

85298: Strait of Le Maire: 54°59′S, 64°53′W, 641–586 m, *Eltanin* sta. 970, 11 Feb 1964. Four small colonies, somewhat damaged. (SEM 1648–1650.)

85300: Tierra del Fuego, north of Cabo San Diego: 53°32′S, 64°57′W, 124–119 m, *Eltanin* sta. 974, 12 Feb 1964. 22 more or less damaged colonies. (SEM 1926–1929.)

85302: East edge of Burdwood Bank: 54°43′S, 55°30′W, 1647–2044 m, *Eltanin* sta. 1592, 14 Mar 1966. Two small colonies, attached to stones with alcyoniids. (SEM 1652.)

85306: Tierra del Fuego, off Cabo San Sebastian: 53°06′S, 67°04′W, 86 m, R/V *Hero* sta. 450, 5 Mar 1970. Nine colonies, one attached to stone, one to pebble, others lacking holdfast. (SEM 1644, 1645, 1658–1660, 1921.)

85308: Tierra del Fuego, off north entrance to Strait of Le Maire: 54°34′S, 64°10′W, 73 m, R/V *Hero* sta. 856, 20 Oct 1971. Five colonies, 2 with holdfast.

85312: Tierra del Fuego, south of Isla de los Estados: 54°55.6′S, 64°21.8′W, 303–358 m, R/V *Hero* sta. 893, 2 Nov 1971. Two colonies lacking holdfast.

88359: Tierra del Fuego, east of Cabo San Sebastian: 53°15′S, 66°51′W, 79–80 m, *Eltanin* sta. 222, 27 Sep 1962. One colony lacking holdfast.

88362: South of Falkland Islands, vicinity of Beauchene Is.: 53°05′S, 59°31′W, 512–586 m, *Eltanin* sta. 339, 3 Dec 1962. Five colonies, three attached to pebbles.

88747: East of Cape Horn: 56°06′S, 66°19′W, 384–494 m, *Eltanin* sta. 740, 18 Sep 1963. Two colonies, one lacking holdfast, one attached to pebble.

88756: Tierra del Fuego, off north entrance to Strait

* Eltanin station numbers 181–297 (Cruise 5, 1962) were duplicated in Cruise 21 (1965).

of Le Maire: 54°34′S, 64°20′W, 91 m, R/V *Hero* sta. 853, 20 Oct 1971. One colony lacking holdfast.

88757: Tierra del Fuego, off north entrance to Strait of Le Maire: 54°29′S, 64°10′W, depth not recorded, R/V *Hero* sta. 855, 20 Oct 1971. One colony.

88758: Tierra del Fuego, off north entrance to Strait of Le Maire: 54°33′S, 64°00′W, 84 m, R/V *Hero* sta. 870, 24 Oct 1971. Two colonies lacking holdfast.

88759: Tierra del Fuego, north of Isla de los Estados: 54°39′S, 63°50′W, 135–137 m, R/V *Hero* sta. 874, 26 Oct 1971. Three colonies, two lacking holdfast.

88760: Tierra del Fuego, off north entrance to Strait of Le Maire: 54°29′S, 63°50′W, 112 m, R/V *Hero* sta. 876, 27 Oct 1971. One colony lacking holdfast.

88763: Tierra del Fuego, Strait of Le Maire: 54°59.9′S, 64°50′W, 438–548 m, R/V *Hero* sta. 895, 3 Nov 1971. One colony lacking holdfast.

89344: Between Tierra del Fuego and Falkland Islands: 52°35′S, 65°08′W, 128 m, *Eltanin* sta. 976, 13 Feb 1964. Forty more or less complete colonies lacking holdfast. (SEM 1930–1934.)

89345: Between Tierra del Fuego and Falkland Islands: 52°35′S, 65°08′W, 128 m, *Eltanin* sta. 976, 13 Feb 1964. About 40 more or less completely denuded pieces of axis.

The 123rd Annual Meeting of the Biological Society of Washington will be held on Tuesday, 7 May, 1996, at 12:00 noon in the Waldo Schmitt Room, National Museum of Natural History, Washington, D.C.